UPPER RIO GRANDE BASIN

WATER & RELATED LAND RESOURCES

NEW MEXICO

OCTOBER 1974

4-34722 2-75
USDA SCS-FORT WORTH, TEX. 1975

UPPER RIO GRANDE BASIN

New Mexico

WATER AND RELATED LAND RESOURCES

A cooperative study effort by the USDA, the New Mexico State Engineer, other State, and Federal agencies.

Prepared by:

USDA, Economic Research Service
USDA, Forest Service
USDA, Soil Conservation Service
in cooperation with
New Mexico State Engineer

October 1974

4-34722 2-75

CONTENTS

CHAPTER III. NATURAL RESOURCES

CHAPTER IV. ECONOMIC DEVELOPMENT

CHAPTER V. WATER AND RELATED LAND RESOURCE PROBLEMS

CHAPTER VI. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED RESOURCE DEVELOPMENTS

CHAPTER VII. EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

FIGURES

PHOTOS

PHOTOS

TABLES

MAPS

FACING PAGE:

MAPS (CONTD)

FOREWORD

This report of water and related land problems, needs, potentials, and opportunities of the Upper Rio Grande Region of New Mexico updates previous studies. The report proposes both current and future alternative activities to aid in meeting these needs.

The report was designed with the reader in mind. Most chapters are arranged in the following order:

1. Economic and Social
2. General Agriculture
3. Forest and Wildlands
4. Floodwater, Erosion, Sediment, and Impaired Drainage
5. Fish and Wildlife
6. Recreation
7. Pollution

This report is a comprehensive, reconnaissance level water and related land plan for the Upper Rio Grande Basin. It was prepared to identify broad problems associated with the water, land, and human resources and to suggest solutions possible through United States Department of Agriculture programs.

<u>The report is not intended to provide decision makers with the details necessary to implement functional programs</u>. It is designed to aid planners in taking a broad look at alternative solutions for inclusion in future functional plans.

In a number of places in this report cost estimates have been displayed by federal and non-federal categories. The divisions are arbitrarily based upon existing cost-sharing policies and do not represent any commitments, agreements, resource uses, or project needs between federal and non-federal interests.

The field work for this report was initiated in 1965. Most of the basic data used in developing the report was 1965-1970 vintage. More recent information has been used where it was convenient or when it was determined to be essential to the usefulness of the report.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

CHAPTER 1

SUMMARY

This section includes statements summarizing the objectives and scope of the study. A brief description of the basin is given including its problems and needs. The findings and conclusions of the study cover the following sections: Development potential of water and related land resources; solutions through USDA programs; and, impacts of potential projects and programs during two periods of time--(1) Early Action (next 10-15 years) and (2) to year 2020.

"The Nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased and not impaired in value. Conservation means development as much as it does protection."

-Theodore Roosevelt

OBJECTIVES AND SCOPE

The objectives of this study were (1) to inventory physical, economic, social, and environmental information, and problems of water and related land resources in the Upper Rio Grande Basin, New Mexico; and, (2) make recommendations for land and water management measures to assure wise and efficient use of the resources in the future.

Problems concerning the conservation and use of the land and water are identified; then, recommendations are made for solving certain aspects of these problems using programs of the United States Department of Agriculture (USDA).

The study was carried out on a reconnaissance level using data from previous investigations whenever possible.

Although the USDA Guidelines for Multiple Objective Planning had not been developed at the beginning of the study (1965), the study objectives and procedures were of such scope that the recommendations in the report could be evaluated within the general framework of the draft USDA guidelines (1971 Greenbook). These guidelines have the following objectives:

1. To enhance national economic development by increasing the value of the nation's output of goods and services and by improving national economic efficiency.

2. To enhance the quality of environment by management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

3. To enhance regional development through increases in a region's income and employment, and improvements in its economic base, environment, quality of life, and other specified components of the regional objective.

Specific objectives of the study were:

1. Identification of opportunities for improving the agricultural economy through small watershed projects under Public Law 566.

2. Identification of areas where watershed treatment might enhance the environment, improve water yield, and contribute to the economy of the basin.

3. To provide a basis for coordination of USDA programs with other state and federal agency activities in watershed protection, flood prevention, and agricultural water management.

4. Appraisal of opportunities for meeting local water and related land objectives with USDA project-type programs.

5. Appraisal of development needs that contribute to the plan for coordinated control, regulation, and management of water and related land resources.

6. Appraisal of the potential, needs, and desires of the human resources and suggestions for programs, procedures, and assistance possible to help the local people contribute fully to the economy, environment, and culture of the basin.

BRIEF DESCRIPTION OF THE BASIN

The Upper Rio Grande Basin includes about 29,696 square miles in north-central New Mexico, involving the drainage area of the Rio Grande and its tributaries from the Colorado state line to Elephant Butte Dam. Included within the boundaries of the basin are parts or all of four closed drainages: Estancia Valley, North Plains, San Augustin Plains, and Jornado del Muerto.

PROBLEMS AND NEEDS

The problems and needs of the basin are as follows:

ECONOMIC AND SOCIAL

Low educational levels, high unemployment rates, low income, and social customs influence land use. There is a need for local employment and training opportunities.

AGRICULTURAL AND FORESTRY

Lack of agricultural management ability and farm technology, seasonal shortages of irrigation water supply, and inadequate or non-existing legal records of land titles constitute the problem. There is a need for training in good management methods, development of higher value crops, improved irrigation systems, and a land title clearing program.

FLOOD DAMAGE

Flood damage occurs on many watersheds in the study area. There is a need for watershed and floodplain studies to assist in planning development.

EROSION

Accelerated erosion and consequent sediment damage are problems of considerable magnitude. In areas of unstable soil, landscapes need intensive land treatment measures to encourage good vegetative cover and to reduce erosion.

LAND USE PLANNING

The phenomenal rate of subdivision development in both urban and rural areas has created problems. There is a need for comprehensive land use planning and zoning for better utilization of land.

IMPAIRED DRAINAGE

High water tables and salt accumulation affect some of the irrigated land. There is a need for a land reclamation program.

WATER

Water problems include obtaining domestic supplies of water for some communities, lack of agricultural water to meet late season requirements, an inefficiency in conveyance and application of water, and water depletion by phreatophytes. Intensive water studies are needed to insure that limited water supplies are used wisely.

WILD AND SCENIC RIVERS

The basin contains about 200 miles of free-flowing streams that need to be studied for possible inclusion in the National Wild and Scenic Rivers System.

WILDFIRE

There is a need to reduce fire hazards by implementing a means to utilize logging debris.

WILDLIFE

Often man's use of the land disrupts fish and wildlife habitat. Habitat needs to be protected and improved for future recreation pressures.

OUTDOOR RECREATION

Outdoor recreation suffers from overcrowded facilities, sanitation disposal, site deterioration, and erosion. The basic need is to enlarge and improve existing facilities and to develop new recreation sites that will be accessible to the public.

POLLUTION

Many communities need sewerage systems. High salinity of irrigation water and livestock feedlot wastes may become pollution problems in the future if care is not taken in planning.

F I N D I N G S A N D C O N C L U S I O N S

DEVELOPMENT POTENTIAL OF WATER AND RELATED LAND RESOURCES

Social-Economic

The rural areas especially suffer from low educational levels and high unemployment rates. The economy is made up primarily of trade and service enterprises. Social customs rather than economic returns often influence land use. Potential development depends on land treatment measures that will more effectively manage water and related land resources. Programs that will stimulate the local economy, improve products, provide sources of employment, and develop opportunities for self sustainment are necessary.

Land Treatment

Past and current indiscriminate development and abuse of land, particularly fragile areas, is approaching critical proportions.

Various land treatment systems are considered essential for achieving the maximum protection of resources on approximately 90,000 acres of abandoned cropland (producing about 14 percent of its potential) and on 1,035,000 acres of low-producing rangeland. Farm irrigation efficiency is about 40 percent and could be increased to 65 percent, on much of the irrigated area, through irrigation water management. Erosion control is needed on over half the study area; stabilization of frail soils is a major need. It is estimated that 45 percent of the timber is old growth that is highly susceptible to damage from insects, disease, and wind. Improvement of timber quality lies in the application of recommended silvicultural treatments.

There are 330,000 acres of undesirable types of brush, utilizing water, space, and nutrients. It is estimated that 74,000 acres of phreatophytes along waterways use 256,280 acre-feet of water annually. The pinyon-juniper woodlands (887,000 acres) will respond to good land treatment and management practices.

Water Development

Projections indicate that the basin can meet OBERS (Bureau of Economic Analysis and Economic Research Service) level water needs through 2020 if the land treatment to increase water yield is applied. Water import and land treatment will be required to meet the state's projected water needs because the projections assume a higher level of cropland development.

The Bureau of Reclamation has made investigations on 11 potential sites for multiple-purpose impoundments (2,781 surface acres). In addition to the sites identified in the feasible P.L. 566 projects, 19 potential sites for single-purpose reservoirs were identified.

It is possible to save and salvage about 263,300 acre-feet of water by improving irrigation and delivery efficiencies, increasing yield from watershed areas, and decreasing non-beneficial water use. Water salvage and savings would add about 173,200 acre-feet to the 1970 available water supply. This includes 81,400 acre-feet of new water.

Agricultural Production

The largest single land use is grazing. There are also about 5 million acres of land suitable for irrigation. Implementation of the recommended program could increase agricultural production about 24 percent by the year 2020.

Flood Protection

Immediate flood protection depends upon initiation of the 19 potential P.L. 566 projects in the basin. Approximately 10 miles of levees and channels and 85 floodwater retarding structures would be required.

Forest Resources

Development potential of forest resources includes improving the quality, more efficient use, and more complete utilization of the wood products. Currently, cultural treatment is only 20 percent of what is needed. Lumber production is the dominant use. It is estimated that 80 percent of the tree growth results in residue rather than lumber. There is an estimated supply of 8.5 million cords of pulp material that can support a 300 to 500 ton-per-day capacity pulp mill. Secondary pulp materials include logging residue, dead and cull trees.

The dry nature of the climate makes the area susceptible to disastrous wildfire. Twenty percent of all wildfires are caused by man.

Outdoor Recreation

Favorable climate and available space present opportunities for expanded recreational development. Possible developments include: 360 miles of Continental Divide Trail, three ski areas, and numerous undeveloped areas of scenic and historical interest. The San Juan-Chama Project includes several reservoirs with potential fish and waterfowl habitat and recreation developments.

Electric Power

The basin has potential to produce a small amount of power by hydroelectric plants.

SOLUTIONS THROUGH USDA PROGRAMS

Problems of the basin can be solved through the mutual concern and collective activities of the local people with assistance from public and private organizations. The USDA role consists of acquiring a basic and reliable inventory data base and serving as technical advisors, consultants, and managers of federally-owned land.

Data relating to land production capabilities, erosion potential, ecological restraints, etc. should be available to all land users. Guidance in conservation, which is the wise use of the water and land resources, can solve many of the basin problems.

Long-standing agricultural activities and customs are being affected by the land use changes of urbanization and industrialization and other demands being exerted on the resources of the basin. The resource potential has to be determined and USDA programs should be oriented to achieve full development of the resources. Should the emphasis change, an alternative approach must be available for selection.

The immediate flood problems can be solved through the 19 potential P.L. 566 watershed projects. The intent of the projects is to reduce flood damages and sedimentation and provide for soil stabilization, water management, and other long-lasting benefits useful to the local people.

Land treatment systems are designed to reduce erosion, protect the land, and enhance crop, range, water, wildlife, recreation, and forest resources. Multiple use management and the recommended land treatment systems provide for the proper administration of resources, the obtaining of balance, and the coordination and programming of various land uses and activities.

IMPACTS OF POTENTIAL PROJECTS AND PROGRAMS

SOCIAL-ECONOMIC

The USDA programs proposed in this report will bring about beneficial economic changes, mostly agricultural, in rural areas. Farm output should increase about 10 percent with the recommended program. Rural income and farm employment should increase slightly. By 1980, over 200 temporary jobs, and over 100 permanent jobs will be created by the recommended program. By 2020, nearly 200 temporary jobs, and over 500 permanent jobs should result from the program. Increases are estimated at less than one percent for the basin as a whole but would decrease unemployment by about 10 percent in the rural areas.

LAND TREATMENT SYSTEMS

Two programs of land treatment systems are considered in this report--(1) an Early Action Program, which includes feasible projects and measures to solve urgent problems, for initiation within the next 10 to 15 years; and (2) the long-range recommended program, which includes the feasible projects and measures needed to the year 2020.

Land treatment on about 3,035,800 acres at a cost of $34,269,900 is needed under the Early Action Program to protect and maintain the land resources for future use. The average annual cost and returns of this treatment are estimated to be $2,922,400 and $5,562,100, respectively, or about $1.90 return for each dollar of cost.

The long-range program entails treatment of 9,092,600 acres at a cost of $101,670,300. This program is estimated to have an average annual cost of $9,392,200 and an average annual return of $20,634,500.

About 2,358,000 acres need to be treated for critical erosion. Approximately 50 percent, or 1,178,000 acres of critically eroded land, should be treated during the Early Action Period at a cost of about $17,700,000. Sediment that reaches floodplains and damage areas would be reduced by about 446 acre-feet annually. Average annual sediment damage reduction benefits are estimated to be about $1,560,000 from the recommended land treatment program.

During the last 30 years the area of phreatophytic growth in the basin has nearly doubled. In 1960 it was estimated that 74,500 acres of river bottom land was covered with phreatophytes, which consumed about 256,300 acre-feet of water annually. If the phreatophyte expansion is not controlled, it is estimated that by 1980 the area will increase to 86,400 acres; and by 2020 to about 111,500 acres with a consumption of 383,000 acre-feet of water annually. By 2020, based on the estimated annual value of irrigation water ($35/acre-foot), the annual consumption by these plants will have a value of about $13,405,000.

The present national forest program returns approximately $1.2 million annually. Further development of the resources through management is estimated to increase the returns by 30 percent. There are some commodities such as water and wildlife for which no monetary collections are made.

There are 221,000 acres of land developed for irrigation in the basin. Approximately 167,000 acres of the developed land are irrigated annually. An estimated 152,900 acres need improved irrigation systems. Irrigation systems could be improved on about 46,000 acres during the next 10 to 15 years at an estimated cost of $5,060,000. Approximately 7,600 acres of the irrigated lands need drainage measures installed during the next 10 to 15 years at an estimated cost of $190,000.

There are about 200 irrigaticn systems needing improvement. During the Early Action Period, approximately 25 percent of the needs could be met at a cost of $2.7 million. There are 30 potential reservoir sites for either irrigation or recreation. The construction cost is estimated at $63.8 million.

Five additional land treatment analyses based on their contribution to the achievement of specific objectives are presented. The objectives illustrated in the analyses are: (1) maximum return for investment; (2) water saving and increased water yield; (3) improvement of water quality through reduction of erosion; (4) employment; and (5) increased forage yield.

P.L. 566 PROJECTS

The recommended program could reduce annual floodwater and sediment damages by an estimated $1,049,000.

Under P.L. 566, 19 watersheds in the basin appear to be feasible for development in the Early Action Period. Total cost of structural measures in these watersheds is estimated at $46,698,000 (1969 prices), with average annual costs of about $2,699,000. Structural measures include 85 floodwater retarding structures and about 50,000 feet of diversion channel. Average annual benefits are about $3,347,000 and provide about $1.24 benefits for each dollar of cost. The proposed structures would control runoff and sediment from 2,138 square miles (1,368,000 acres) or 7 percent of the basin area.

RURAL RENEWAL

Provisions for water and sewerage facilities to meet community needs by the year 2020 will cost more than $633 million. Twenty of the 95 communities in the basin need municipal water systems and 63 communities need sewerage systems. In 29 communities the water supply is of poor chemical quality and classified as hard to very hard. Based

on OBERS population and water use projections, household and industrial water depletions will increase from 37,726 acre-feet in 1967 to 175,837 acre-feet in the year 2020.

Solid waste disposal costs will probably rise to more than $13,213,000 by the year 2020. Solid waste generation in the basin, estimated at three pounds per capita per day, produced an aggregate of 311,900 tons in 1970. Projected tonnage of solid waste will rise to 1,205,700 tons per year by 2020.

CHAPTER II

Introduction

Included in this chapter are the reasons why the river basin study was needed and the purpose and objectives of the study. A brief description of the study area is followed by an account of the authority and policy for the study. A brief description of how the study was made, uses of the report, a section on water rights administration, and New Mexico water law are included.

WHY THE STUDY WAS NEEDED

The primary purpose of the USDA-New Mexico cooperative river basin study is to determine where improvements can be accomplished in the use of water and related land resources, with social, economic, and environmental impacts, through the assistance of the Department's projects and programs.

The State of New Mexico assists local people and their organizations in the conservation, development, and management of land and water resources through federal, state, and local programs and projects. An important responsibility of the State is coordinating state and federal activities to help solve water and related land problems for the people.

Knowledge of any area's basic resources, problems, needs, opportunities, and impacts is imperative before intelligent decision making can occur. One of the effective means of interpreting needed resource data is through the qualitative, quantitative, and monetary analysis of resources.

The magnitude and significance of some of the problems and possible solutions are indicated in this report. The extent to which various USDA programs assist in meeting these needs is evaluated.

PURPOSE AND OBJECTIVES

The purpose of this study is to help plan for the development, management, and use of water and related land resources of the Upper Rio Grande Basin. This study will provide the local people, the State of New Mexico, and federal agencies with alternative courses of action for: (1) the development, conservation, and use of the natural and human resources; and (2) the improvement of the economic and social opportunities of the people.

The study has the following principal objectives:

1. To identify management areas feasible for treatment of vegetative cover, including forest types; to improve water yield; and to appraise the economic effects of such treatment.

2. To provide a technical basis for more effective coordination of USDA programs with similar activities of local, state, and other federal agencies.

3. To identify and describe opportunities for assistance in improving social conditions, environmental problems, and the economy of the basin through the use of small watershed projects under P.L. 566.

4. To appraise opportunities for meeting local water and related land objectives through other USDA project-type programs.

5. To appraise the agricultural rural community and upstream watershed needs of the basin; and to present alternatives for the coordinated and orderly control, regulation, management, and use of the water and related land resources.

6. To identify feasible structural measures and associated land treatment and management systems that should be provided in the next 10 to 15 years to meet the needs of improving and developing the land and water resources in the basin.

DESCRIPTION OF THE STUDY AREA

The 19,005,260-acre study area (approximately 29,696 square miles) has over 500,000 residents--about half of the State's population. About 56 percent of the basin population resides in Albuquerque, the largest city in the State, and Santa Fe, the state capitol. Social indicators (i.e., income, education, and unemployment) range from some of the highest levels in the State to some of the lowest levels.

The area is characterized by extremes in physical features. Elevations range from about 4,200 feet to over 13,000 feet; precipitation from about 6 inches to about 35 inches annually; mean annual temperature is from about 39 to 61 degrees F., and a frost-free period range from about 95 days to more than 200 days. Vegetation zones include alpine conditions in the north and semi-desert features in the south.

The study area includes all of the land drained by the Rio Grande and tributaries in New Mexico above Elephant Butte Dam. Principal tributaries to the Rio Grande within the study area are the Rio Chama, Rio Taos, and Rio Puerco. Other tributaries include Costilla Creek, Red River, Rio Hondo, Embudo River, Santa Fe River, Galisteo Creek, Jemez River, Rio Salado, and the Alamosa River. Adjoining river systems are the Upper and Lower Colorado on the west and the Arkansas-White-Red and Upper Pecos on the east. The area contains three closed drainage basins--the Estancia Valley, the North Plains, and the San Augustin Plains (shown on some maps as "Plains of Saint Augustine" or "San Augustine Plains"). It also includes about 70 percent of the Jornado del Muerto.

The basin extends about 240 miles north to south and about 120 miles east to west. The Colorado state line on the north and Elephant Butte Dam on the south are the boundaries of the Upper Rio Grande study area. The Continental Divide forms the west boundary. The east boundary follows the west-side drainage of the mountain ranges from the Sangre de Cristo to the San Andres.

The study area includes all or part of the following counties: Bernalillo, Catron, Colfax, Lincoln, Los Alamos, McKinley, Mora, Rio Arriba, Sandoval, San Miguel, Santa Fe, Sierra, Socorro, Taos, Torrance, and Valencia.

The area is strategically located for tourism and recreation. Cool summer weather in the mountains attracts many vacationers, particularly from adjacent areas to the south and east. A significant number of people spend the winter months in the southern part of the basin where the climate is mild and dry.

The landownership is typical of other western states--about 40 percent private, 40 percent federal, 11 percent Indian, and 9 percent state land.

About 78 percent of the land is rangeland used primarily for grazing livestock, 13 percent is commercial forest, and only 2 percent is cropland. Two-thirds of the area classed as commercial forest is also used for grazing. The remaining 7 percent of the land supports roads, railroads, urban, and other miscellaneous uses.

USDA AGENCIES PARTICIPATING IN THE STUDY

USDA agencies participating in the study are the Soil Conservation Service, the Forest Service, and the Economic Research Service. The study is in accordance with a mutual Memorandum of Understanding dated May 6, 1968.

AUTHORITY AND POLICY FOR STUDY

The State of New Mexico, through the State Engineer's Office, a sponsor and cooperating agency, requested USDA's assistance in conducting a study of the Upper Rio Grande Basin. This study was made under the authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83d Congress (Public Law 566, amended). This act authorizes the Secretary of Agriculture to cooperate with other federal, state, and local agencies in investigating watersheds, rivers, and other waterways for the development of coordinated programs.

The study was conducted within the scope and guidelines of national policy that was directed by the National Water Resources Council. The Congress declared in the Water Resources Planning Act (Public Law 89-80) a policy to *encourage the conservation, development, and utilization of water and related land resources of the United States on a comprehensive and coordinated basis by all levels of government*

and nongovernment entities and individuals. This study is not a part of the Water Resources Council program but is coordinated with the Council.

HOW THE STUDY WAS MADE

A team approach was used throughout the study. The team included soil conservationists, economists, civil engineers, soil scientists, agronomists, geologists, hydraulic engineers, and a forester. Assistance from other disciplines was requested as needed. The team made field reconnaissances of the basin to become familiar with the area. Available reports were reviewed for data that might be helpful in determining problems and problem areas and in establishing a resource inventory base.

The Conservation Needs Inventory (CNI) was used as a starting point in locating floodwater problems and in determining management and treatment needs of agricultural land. Those watersheds with resource problems listed in the CNI report were investigated by the field party to determine land treatment needs, structural program alternatives, and economic justification of the structural program. Watershed Investigation reports were prepared for those watersheds considered feasible.

Reconnaissance of the basin disclosed several watersheds, not indicated in the CNI, that had problems and could be handled under P.L. 566. Watershed Investigation reports were prepared for these watersheds also. Procedures used in evaluating watersheds under P.L. 566 were followed to determine potential projects in the basin.

Land treatment systems were developed in detail for several typical areas and then expanded as appropriate throughout the basin. The criteria for these systems were developed in cooperation with the Forest Service, the Bureau of Land Management, the Bureau of Indian Affairs, and field personnel of the Soil Conservation Service.

The effect of land treatment systems on water yield, increased forage, and reduced erosion was estimated. The effect on water yield was based on data collected by the Forest Service from experimental watersheds adjusted to the physical and climatic conditions in the study area.

"Project Work Inventory" (PWI) and various resource inventories made by the Forest Service were used to express facts and findings relating to National Forest lands. These efforts were utilized to prepare the alternative programs.

Baseline economic projections were made based on the national OBERS projections. Primary economic impacts were estimated using SCS cost-return procedures. Input-output models were used to estimate secondary

economic impacts of the recommended programs in the basin. The recommended water use programs were developed in compliance with the statutes and rules for appropriation of water for beneficial use.

WATER RIGHTS ADMINISTRATION - NEW MEXICO WATER LAW

New Mexico law provides that surface and underground waters belong to the public and are subject to appropriation for beneficial use. Such use is the basis, measure, and limit to the right to use water. Priority in time gives the better right. The underlying principle is known as the appropriative doctrine of water rights. Where it applies, the mere physical presence of water upon, within, or adjacent to land does not confer upon the owner of the land the ownership of the water or a right to its use.

Water rights are administered by the New Mexico State Engineer in accordance with provisions of the constitution and statutes, the adjudication of the courts, the terms of interstate compacts, and the rules and regulations of the State Engineer. The State Engineer has jurisdiction over underground water basins that are declared by him to have reasonable, ascertainable boundaries. About 17,700 square miles of the basin lie within declared underground water basins.

Eight interstate compacts, to which the State is signatory, affect the development and use of water in New Mexico. Where there is a close relationship between the occurrence of ground water and the flow of surface streams, a coordinated administration of diversions by wells and by surface works may be required in order to insure that valid water rights are served. The State's ability to meet interstate water delivery obligations must also be preserved.

The Rio Grande Compact between the states of Colorado, New Mexico, and Texas apportions waters of the Rio Grande stream system above Fort Quitman, Texas to the states. The compact defines the obligation of the upstream states to deliver water by schedules that establish the outflow that must be maintained with a given inflow. New Mexico's obligation to deliver water to Elephant Butte Dam is established by the flow of the Rio Grande at the Otowi gage. The compact requires that appropriate adjustments be made in streamflows to reflect changes in depletion after 1929 in the application of the schedules. It defines the storage of water in reservoirs in New Mexico above San Marcial for those constructed after 1929, and protects the priority of the storage right of Elephant Butte Reservoir. The compact provides that the State having the right to the use of water imported to the Rio Grande Basin shall be given proper credit in the application of the schedules for delivery of water. Works to divert and regulate water from the San Juan River drainage to the Upper Rio Chama have recently been completed by the U. S. Bureau of Reclamation.

The amended Costilla Creek compact, between Colorado and New Mexico, provides for equitable apportionment of water in Costilla Creek and for the integrated operation of existing and prospective irrigation facilities on the stream in the two states.

Except for the closed basins, waters are fully appropriated; consequently, no new depletion of the available surface water supply is allowed. Permit to change the place and purpose of existing water uses may be obtained provided such changes can be made without impairment of existing rights. New uses may also be allowed if their effect on existing rights can be offset by imported water. Also, in declared ground water basins, ground water may be appropriated for new uses if the effects of such appropriations are offset by retirement of existing valid surface water uses.

The use of water in the National Forest System is based on the principle that when land was reserved from the public domain for National Forest purposes, water to achieve these purposes was reserved as well. The water use priority dates from the time the National Forest was withdrawn from the public domain. This is known as the "reservation principle".

An objective of the Forest Service is to obtain sufficient water, in addition to that covered by the Reservation Doctrine, in accordance with legal authority to provide for the development, use, and management of the National Forest resources.

USES OF THE REPORT

This report presents options for the use and management of natural resources, their cost, benefits, and impacts. The usefulness of the report will be in direct proportion to the interest and actions of local decision makers as they select from the options and alternatives presented. It is also a guide for local, state, and federal interests in conserving, developing, and utilizing water and related land resource programs. It informs interested parties of USDA programs of assistance that may help solve some of the basin's problems. If local decision makers wish, the report can be a basis for their pursuit of implementation actions. Other possible uses of the report include:

1. To provide information regarding resource problems, alternative courses of action for solving these problems, and the probable results.

2. To indicate how local and federal action programs utilizing natural resources can support new industry, expand business activity, encourage growth in the economy, and conserve the land and water resource base.

3. To identify opportunities for coordinating state and federal agency programs to make maximum contributions to the conservation and use of natural resources.

4. To help natural resource conservation district officials revise and update long-range programs of work.

5. To help cities and counties evaluate development trends and use the data as a basis for projecting current and future needs.

6. To assist the regional, state, and county planning organizations (Four Corners Regional Commission, Councils of Government, Resource Conservation and Development Districts, etc.) in the identification of rural and urban problems and suggestion of ways to utilize more completely the natural, human, economic, and social resources to solve these problems.

ACKNOWLEDGMENTS

Many state and federal agencies have provided data and assistance for this report. Significant contributions have been received from private individuals, business firms, and the State's universities.

CHAPTER III

Natural Resources

This chapter includes the qualitative and quantitative expression of land and water resources of the basin. A brief description of the topography, climate, and physiography is included to give the reader a picture of the basin. The land resources are described relative to land ownership and use, types of soils, vegetation and cover, and capability. This indicates the present condition of the basin and helps in determining the land resource potential of the basin.

The water resources of the basin, both surface and subsurface (ground water), and water quality are described. Water depletion, use, and management are also discussed. A brief qualitative description of fish and wildlife resources and scenic beauty complete the discussion of the natural resources of the basin.

PHOTO III-1. PEACEFUL LANDSCAPE, UPPER RIO GRANDE BASIN, NEW MEXICO SCS PHOTO

GENERAL DESCRIPTION

TOPOGRAPHY

Topography of the basin ranges from high, mountainous terrain to rolling plains. Wheeler Peak, 13,160 feet above mean sea level, is the highest point in the state. Many of the other mountains in the basin are more than 10,000 feet in elevation. The lowest elevation in the basin is at Elephant Butte Dam, about 4,200 feet above mean sea level.

CLIMATE

Climatic conditions range from semiarid in the lower elevations to semihumid in the mountainous regions. Average annual precipitation varies from about 8 inches at Truth or Consequences to about 35 inches in the Sangre de Cristo Mountain Range. Average annual precipitation in the main valley is from 6 to 12 inches.

Temperatures range from an average of 61.2 degrees F. at Truth or Consequences to 47.4 degrees F. at Taos. The average frost-free season is from May 25 to September 30, or 125 days at Taos; and from April 27 to November 12, or 200 days at Truth or Consequences.

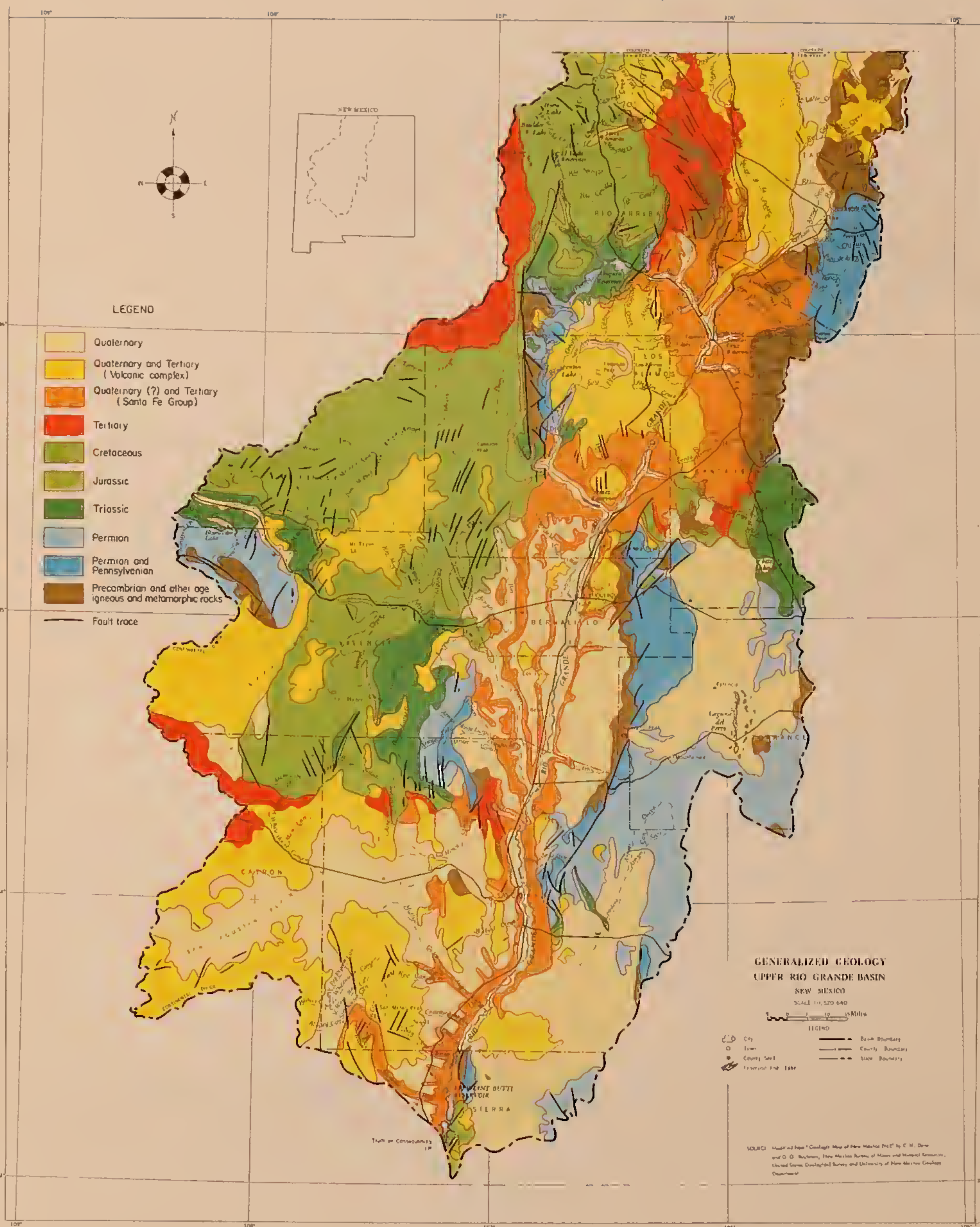
PHYSIOGRAPHY AND GEOLOGY

PHYSIOGRAPHY

The Upper Rio Grande Basin in New Mexico includes the Navajo and Datil sections of the Colorado plateau physiographic province, the Southern Rocky Mountains province, and the Mexican Highlands and Sacramento sections of the Basin and Range Physiographic province (Fenneman, 1931). The Colorado Plateaus province includes buttes, mesas, lava flows, volcanic rocks, and broad valleys. The Southern Rocky Mountains province includes complex mountains, intermontane basins, and deep canyons. The Basin and Range province includes isolated ranges separated by plains and broad valleys of the Mexican Highlands section and the mature block mountains of gently tilted strata, block plateaus, and bolsons in the Sacramento section.

MINERAL RESOURCES

Mineral deposits in the basin include turquoise (a semi-precious mineral highly esteemed as insets of Indian-made jewelry), silver, lead, iron, and manganese ores. The majority of the uranium mined in the basin is in the western part of the state in McKinley and Valencia Counties.


NEW MEXICO
N
LEGEND
Quaternary
Quaternary and Tertiary (Volcanic complex)
Quaternary (?) and Tertiary (Santa Fe Group)
Tertiary
Cretaceous
Jurassic
Triassic
Permian
Permian and Pennsylvanian
Precambrian and other age igneous and metamorphic rocks
Fault trace
RIO ARRIBA
LOS ALAMOS
BERNALILLO
RIO GRANDE
CATRON
SIERRA
TORRANCE
GENERALIZED GEOLOGY
UPPER RIO GRANDE BASIN
NEW MEXICO
Miles
City
Town
County Seat
Basin Boundary
County Boundary
State Boundary

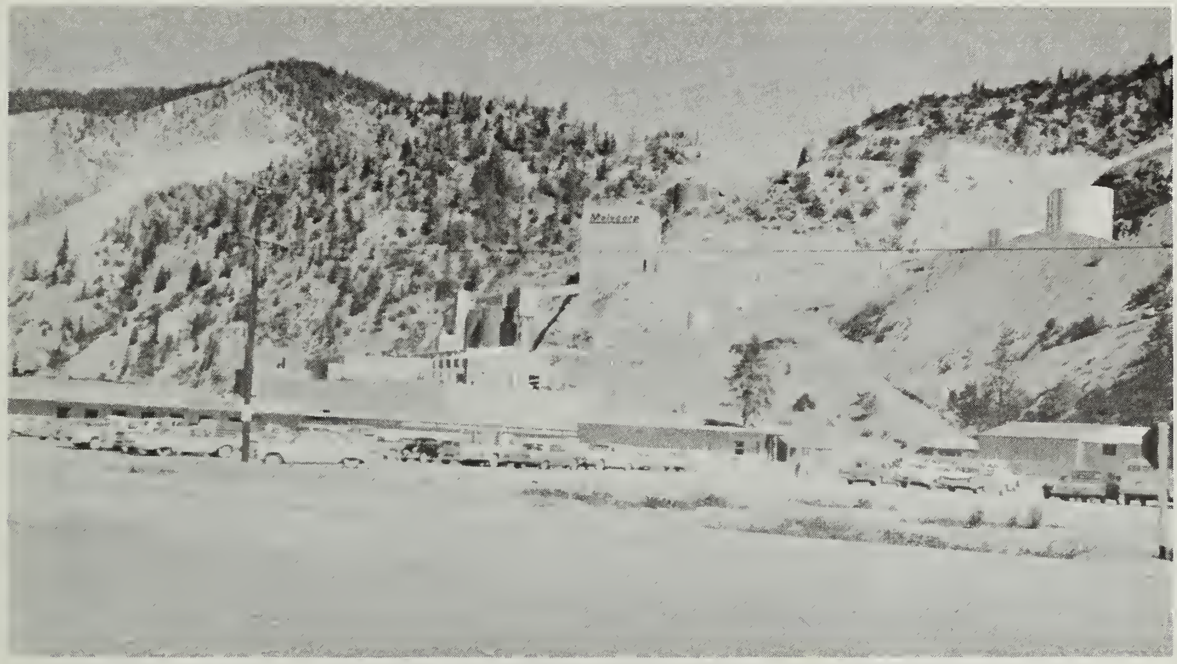


PHOTO III-2. MINING MOLYBDENUM ORE, RED RIVER, NEW MEXICO

The following quote relative to kyanite and mica was taken from New Mexico Business (1969). *"In October, Representative Tom Morris predicted a mica boom for northern New Mexico where deposits of mica and kyanite are extensive. The prediction was based on the reaction of experts from the Metallurgy Laboratories of Alabama . . . The visitors labeled them the largest and best quality kyanite and mica deposits known in the world."*

Molybdenum ore ranks high in mining resources in the Basin. The following is taken from New Mexico Business (1969). *"B. C. Lansing, general manager of Molycorp's Questa division, says that at the planned mining rate, this new total (157,009,000 tons of proved and probable ore) should last 17 years."*

PHOTO III-3. NATURAL GAS COMPRESSOR STATION NEAR GRANTS, NEW MEXICO.

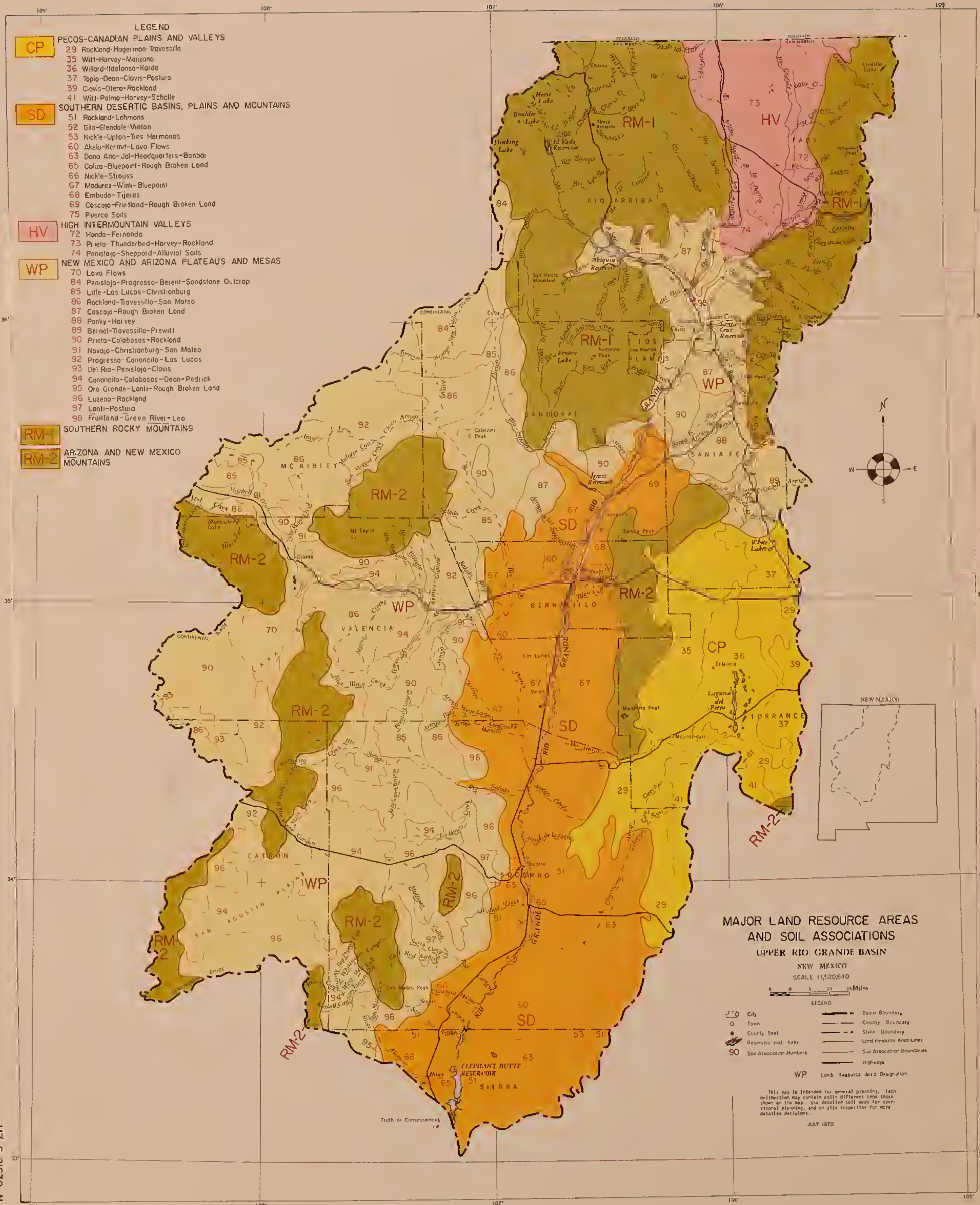
STRATIGRAPHY AND STRUCTURE

Sedimentary, metamorphic, and igneous rocks are exposed in the basin. They range in age from Precambrian to Quaternary. Although these three types of rock are exposed in the basin, there are rocks of all ages that may not be exposed. The geology map of the basin shows the distribution of sedimentary and volcanic associated rock as well as the igneous and metamorphic rock. According to Dane (1965): *"During much of Paleozoic time the relief in New Mexico was low and intermittent... During the late Paleozoic (Pennsylvanian and Early Permian) time there was local mountain building...During late Tertiary time, most of the mountains and basins that are part of the present landscape of New Mexico were formed."*

LAND RESOURCES

LAND STATUS

The administration or ownership of land within the area is shown in Table III-1, page III-5.



LEGEND
CP PECOS-CANADIAN PLAINS AND VALLEYS
29 Rockland-Hagerman-Travessilla
35 Witt-Harvey-Manzano
36 Willard-Idelonso-Karde
37 Tapia-Dean-Clovis-Postura
39 Clovis-Otero-Rockland
41 Witt-Palma-Harvey-Schalle
SD SOUTHERN DESERTIC BASINS, PLAINS AND MOUNTAINS
51 Rockland-Lehmans
52 Gila-Glendale-Vinton
53 Nickle-Upton-Tres Hermanos
60 Akela-Kermit-Lava Flows
63 Dona Ana-Jal-Headquarters-Banbar
65 Caliza-Bluepoint-Rough Broken Land
66 Nickle-Strauss
67 Madurez-Wink-Bluepoint
68 Embudo-Tijeras
69 Cascajo-Fruitland-Rough Broken Land
75 Puerco Soils
HV HIGH INTERMOUNTAIN VALLEYS
72 Hondo-Fernando
73 Prieta-Thunderbird-Harvey-Rockland
74 Penistaja-Sheppard-Alluvial Soils
WP NEW MEXICO AND ARIZONA PLATEAUS AND MESAS
70 Lava Flows
84 Penistaja-Progresso-Berent-Sandstone Outcrop
85 Litle-Los Lucas-Christianburg
86 Rockland-Travessilla-San Mateo
87 Cascajo-Rough Broken Land
88 Panky-Harvey
89 Bernal-Travessilla-Prewitt
90 Prieta-Calabasas-Rockland
91 Navajo-Christianburg-San Mateo
92 Progresso-Canoncito-Los Lucas
93 Del Rio-Penistaja-Clovis
94 Canoncito-Calabasas-Dean-Pedrick
95 Oro Grande-Lonti-Rough Broken Land
96 Luzena-Rockland
97 Lonti-Postura
98 Fruitland-Green River-Leo
RM-1 SOUTHERN ROCKY MOUNTAINS
RM-2 ARIZONA AND NEW MEXICO MOUNTAINS
MAJOR LAND RESOURCE AREAS AND SOIL ASSOCIATIONS
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
NEW MEXICO
RIO ARRIBA
TAOS
SANDOVAL
LOS ALAMOS
SANTA FE
McKINLEY
BERNALILLO
VALENCIA
TORRANCE
CATRON
SOCORRO
SIERRA
Abiquiu Reservoir
Jemez Reservoir
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
Estancia
Belen
Los Lunas
Socorro
Laguna del Perro
Manzano Peak
San Mateo Peak
Mt Taylor
Sandia Peak
JULY 1970

M7-S-21630-N

TABLE III-1. ADMINISTRATION OR OWNERSHIP OF LAND

Percent	Acres	Status
21	3,992,000	Administered by Forest Service
14	2,744,800	Administered by Bureau of Land Management
9	1,637,200	Administered by State
40	7,618,260	Privately Owned
11	2,053,900	Indian Land
5	959,100	Defense, Miscellaneous Federal Land
---	----------	
100	19,005,260	

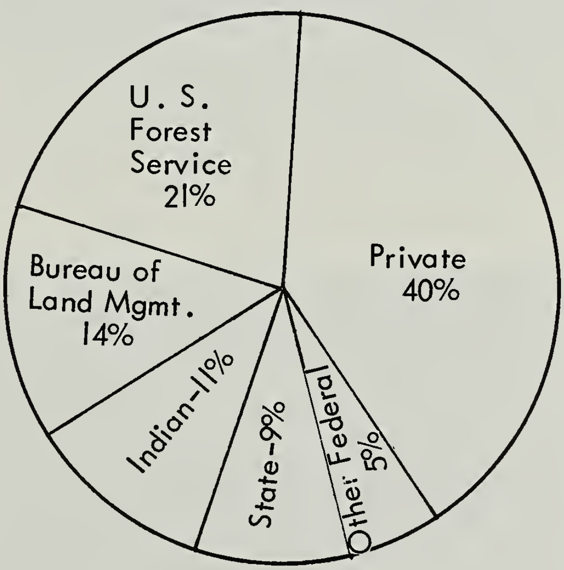


FIGURE III-1. LAND OWNERSHIP

LAND RESOURCE AREAS (LRA)

The individual LRA's are geographical areas characterized by particular patterns of soil (including slope and erosion), climate, elevation, water resources, land use, and type of agriculture. There are six significant land resource areas within the basin as follows:

New Mexico and Arizona Plateaus and Mesas (WP)

This LRA is located in the western part of the study area at elevations of 5,500 to 7,000 feet above mean sea level. The vicinities of Grants and the San Augustin Plains are typical of this LRA. Shrubs and short grasses are the main vegetation, but pinyon and juniper trees occupy the shallow soils and higher elevations. The land is usually used for grazing, except for scattered areas of irrigated land along the Rio San Jose and Rio Puerco which produce climatically adapted field crops. The area is characterized by gently sloping mesas and plateaus surrounded by steep cliffs. Thirty-nine percent of the basin is included in this LRA.

Southern Rocky Mountains (RM)

Predominant in the northern third of the basin, this LRA is characterized by steep mountains dissected by narrow stream valleys. Elevations range from 6,000 to 13,000 feet above mean sea level. Upper mountain slopes support forests of mixed conifer consisting of spruce, fir, pine, and aspen. Pinyon and juniper trees and sagebrush occur at lower elevations. The high elevations are utilized for water yield, summer grazing, forestry products, wildlife, and recreation. The lower elevations are mostly rangeland except for scattered irrigated fields of

PHOTO III-4. NEW MEXICO AND ARIZONA PLATEAUS AND MESAS LAND RESOURCE AREA. ACOMA PUEBLO (SKY CITY) IN DISTANCE.

PHOTO III-5. SOUTHERN ROCKY MOUNTAINS LAND RESOURCE AREA. PHOTO TAKEN NEAR CUBA, NEW MEXICO.

native hay and alfalfa along the bottom lands. High plateaus and steep-walled canyons are common. Seventeen percent of the basin is included in this LRA.

Southern Desertic Basins, Plains, and Mountains (SD)

This LRA is located along the Rio Grande. The northernmost point is about 10 miles north of the mouth of the Galisteo River. Elevations range from 4,000 to 6,500 feet. Irrigation projects in this LRA are adjacent to the Rio Grande. Desert shrubs and short grass cover much of the upland areas. Alfalfa, cotton, orchards, vegetables, and irrigated pastures are the main crops. The area is principally used as rangeland. The livestock carrying capacity of the rangeland is generally low because of limited rainfall and high temperatures. It is part of the large desert LRA that extends from the southwestern corner of New Mexico to the Big Bend Country in Texas. Twenty percent of the basin is in this LRA.

Arizona and New Mexico Mountains (RM2)

This LRA is similar to the Southern Rocky Mountain area except for slightly higher average annual temperatures. Elevations range from approximately 5,000 to 10,700 feet above mean sea level. The higher elevations are mixed conifer and ponderosa pine forests, while the lower elevations are covered with pinyon and juniper, brush, and mixed grasses. Most of the area is rough and steep and is used for water yield, forest and woodland products, wildlife, livestock production, and recreation. This LRA is represented within the basin by the Sandias, San Mateo, and Datil Mountains. Nine percent of the basin is in this LRA.

PHOTO III-6. SOUTHERN DESERTIC BASIN PLAINS AND MOUNTAINS LAND RESOURCE AREA. PHOTOGRAPH TAKEN EAST OF ELEPHANT BUTTE RESERVOIR, NEW MEXICO SCS PHOTO 12-P992-14

PHOTO III-7. TYPICAL OF ARIZONA AND NEW MEXICO MOUNTAINS LAND RESOURCE AREA SCS PHOTO 12-P954-1

PHOTO III-8. PECOS-CANADIAN PLAINS AND VALLEYS LAND RESOURCE AREA. PHOTOGRAPH TAKEN NEAR MOUNTAINAIR, NEW MEXICO.

Pecos-Canadian Plains and Valleys (CP)

Elevations in this LRA range from 5,000 to 6,000 feet. The LRA is primarily grassland with scattered woodland used for grazing livestock. Usually, the slopes of the dissected high plain are gently sloping or rolling except where bands of steep slopes and rough, broken land border stream valleys. Part of this gently sloping LRA is in the eastern part of Torrance and Socorro Counties. Ten percent of the basin is included in this LRA.

High Intermountain Valleys (HV)

The area consists of level to gently sloping valley fill material at elevations of 7,000 to 9,000 feet. Much of the area is underlain at a shallow depth by basalt. Shrubs and short grasses, predominantly big sagebrush and blue grama, comprise a large percentage of the vegetative cover. The area is used as rangeland and irrigated cropland. This LRA lies almost entirely within Taos County and includes five percent of the basin.

SOILS

Soil is a collection of natural bodies on the surface of the earth, containing living matter and supporting, or capable of supporting, plants. The soils in the basin are closely related to the patterns of geologic

parent material. Many of the soils are relatively immature with physical and chemical characteristics influenced by the associated rock formations. The soil-water-plant relationships have definite effects on the economy of the area. The basin also has a variety of soil conditions that influence the quantity and quality of water.

Several soil areas influence water yield. Mountain soils absorb and store moisture from winter snows. They provide the fertile and firm footing for stands of trees and other vegetation that protect the steep slopes from erosion. Some of the water absorbed by mountain soils is released into streams throughout the year, some is evaporated, and some is worked into ground water aquifers.

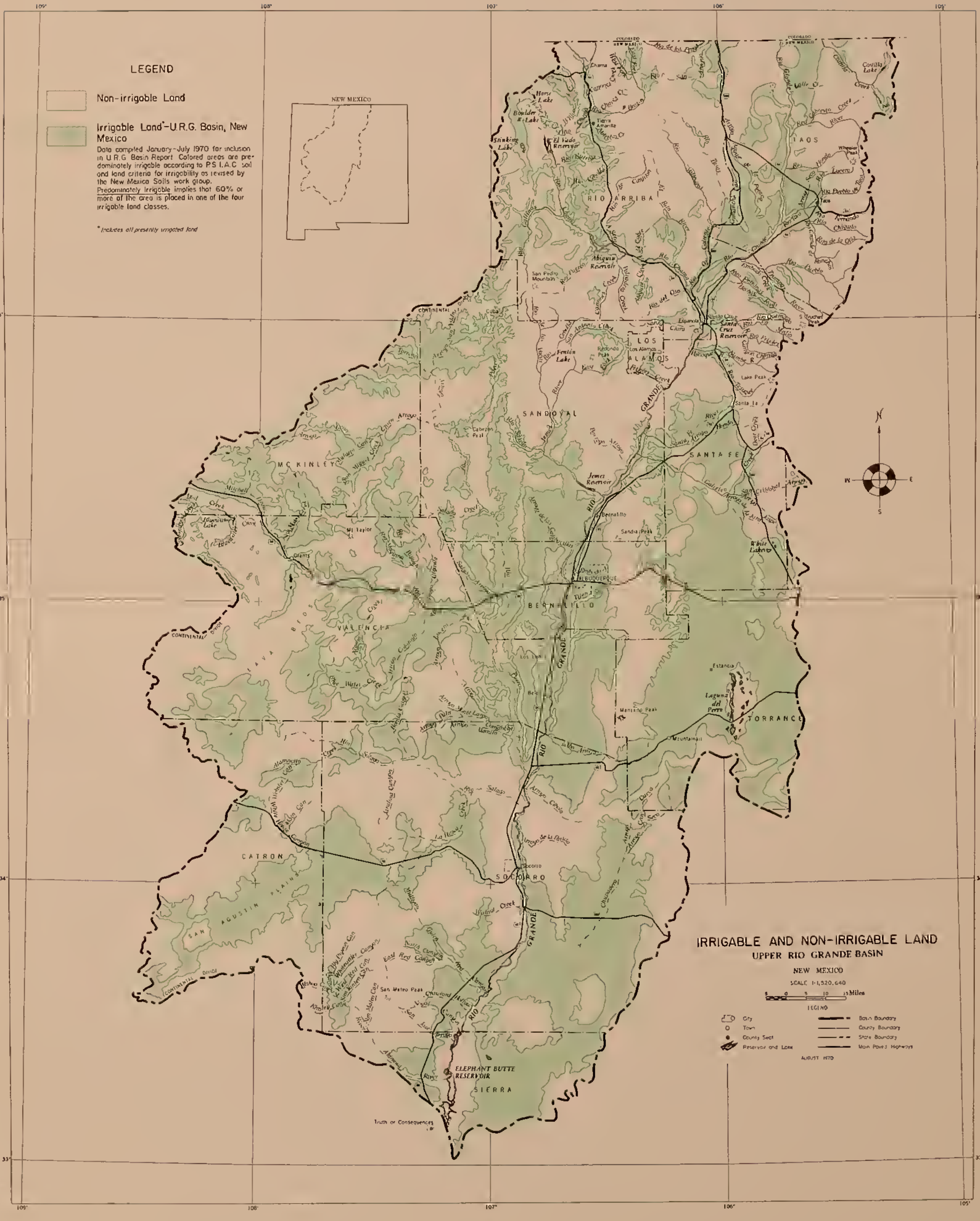
There are possibilities of decreasing water consumption on the deep soils of the bottom lands. Plant species of little economic benefit such as saltcedar take advantage of soil fertility and high water tables to replace more economically desirable vegetation. Such phreatophytic vegetation uses large amounts of water (Soil Associations 52, 75, and 98).

Many soils are fragile and when subjected to overuse or misuse, present serious erosion problems. Some of the soils that are sediment contributors are associated with the Santa Fe group (Soil Associations 65, 67, 68, 69, and 87). They are of highly erosive materials and contribute a large amount of damaging sediment to stream channels, reservoirs, and irrigated cropland.

Soils developing on the clayey alluvium and residuum of the Mancos shales, in the vicinity of Tierra Amarilla and El Vado Reservoir, provide the Rio Chama with its characteristic muddy appearance. The Rio Puerco drainage has many soils that are influenced by soft shale deposits (Soil Associations 75, 85, 87, and 92) and contribute large amounts of sediment to the Rio Grande.

Irrigation water is used mainly on soils on the bottom land areas (Soil Associations 35, 36, 52, and 98). Approximately one-third of the basin area is mantled with soils capable of producing adapted crops if irrigation water were available (Soil Associations 35, 36, 37, 52, 63, 67, 72, 79, 94, and 98). See the Irrigable and Non-Irrigable Land Map for the location of irrigable soils.

The Major Land Resource Areas and Soil Association Map shows the soil patterns in the basin. (Since the first draft of this report, Soil Association maps and Irrigable Land Studies have been completed for all counties. The names and numbers of the reports are located in the reference section at the end of this chapter.)


LEGEND
Non-irrigable Land
Irrigable Land*-U.R.G. Basin, New Mexico
Data compiled January-July 1970 for inclusion in U.R.G. Basin Report. Colored areas are predominately irrigable according to P.S.I.A.C. soil and land criteria for irrigability as revised by the New Mexico Soils work group. Predominately Irrigable implies that 60% or more of the area is placed in one of the four irrigable land classes.
* Includes all presently irrigated land
NEW MEXICO
IRRIGABLE AND NON-IRRIGABLE LAND
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
Miles
City
Town
County Seat
Reservoir and Lake
Basin Boundary
County Boundary
State Boundary
Main Paved Highways
AUGUST 1970
RIO ARRIBA
TAOS
SANDOVAL
LOS ALAMOS
SANTA FE
MC KINLEY
VALENCIA
BERNALILLO
TORRANCE
CATRON
SOCORRO
SIERRA
RIO GRANDE
ELEPHANT BUTTE RESERVOIR
Albuquerque
Truth or Consequences

M7-S-21769-N

Suitability of Land for Irrigation

The land in the area has been grouped into five different classes based on land characteristics affecting suitability for irrigation development (considers soil as a resource and disregards availability of water) and sustained productivity (criteria for classification - Pacific Southwest Interagency Coordinating Committee). The principal characteristics used are slope, texture, topography, depth, water holding capacity, permeability, alkalinity, drainage, erodibility, and salinity. The map, entitled "Irrigable and Non-Irrigable Land", reflects refinement of the general soil map by knowledgable, local field technicians.

Suitability decreases from Class I to VI land because of decreasing yields and kinds of adapted crops, increasing costs of development, maintenance, and limitations of land characteristics. Class IV is undesirable and Class VI is not suitable for irrigation.

TABLE III-2. LAND CAPABILITY

Class	Acres	Capability	Percent
I	692,100	High yields for nearly all adapted crops, minimum cost of development and maintenance.	4
II	2,113,500	Moderately productive for adapted crops. Moderate cost of development and maintenance. Moderate limitations, one or more adverse land characteristics.	11
III	2,574,300	Restricted production for majority of crops. High cost of development and maintenance. Severe limitations, one or more adverse land characteristics.	13
IV	2,622,000	Few crops adapted because of severe limitations of land characteristics.	14
VI	11,003,360	Not suitable for sustained irrigation because of extreme limitations of one or more land characteristics.	58
	19,005,260		100

FOREST LANDS

Forest lands in the basin comprise 42 percent (8 million acres) of the area. Two broad classifications have been used to describe these lands. They are (1) commercial, and (2) non-commercial forests.

The commercial forest encompasses 2.4 million acres and contains about 8.3 billion board feet of timber. This amounts to about 38 percent of the state's commercial forest acreage. The annual commercial harvest is about 125 million board feet. There are about 8 million cords of pulp size material suitable for harvest. The conifer species above the ponderosa pine zone account for 35 percent of the commercial acreage and 58 percent of the volume. Ponderosa pine is the most important commercial species. It accounts for 58 percent of acreage and 37 percent of the volume.

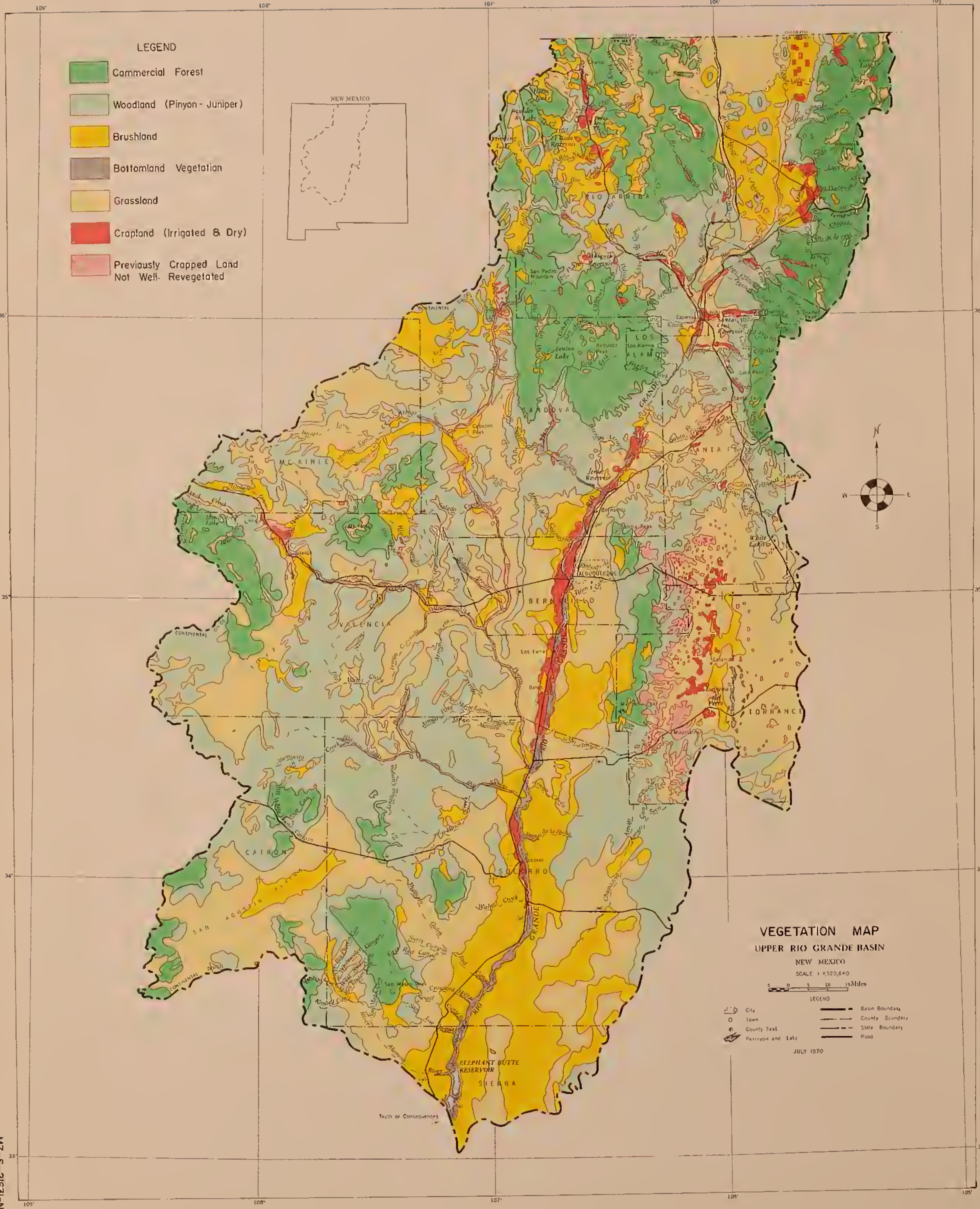
TABLE III-3. AREA OF COMMERCIAL FOREST LAND BY TYPE, OWNERSHIP, AND VOLUME (MILLION BOARD FEET) - UPPER RIO GRANDE BASIN, NEW MEXICO

Ownership	Unit	Spruce Fir	Mixed Conifer	Ponderosa Pine	Aspen	Total
National	Acres	165,700	469,300	862,000	134,000	1,631,000
Forest	bd.ft.	1,391.9	2,908.0	2,505.8	397.9	7,203.6
State and	Acres	50,000	155,000	502,000	10,000	717,000
Private 1/	bd.ft.	75.0	225.0	451.0	25.0	776.0
Indian	Acres	3,000	26,000	40,000	15,000	84,000
Trust 2/	bd.ft.	15.0	115.0	128.0	37.6	295.6
Other	Acres	-	-	5,000	-	5,000
Federal	bd.ft.	-	-	20.0	-	20.0
TOTALS	Acres	218,700	650,300	1,409,000	159,000	2,437,000
	bd.ft.	1,481.9	3,248.0	3,104.8	460.5	8,295.2

1/ Data from State Forester, New Mexico
2/ Data from Bureau of Indian Affairs

According to Choate (1966) the commercial forest in New Mexico is growing slightly more than 8 cubic feet per acre per year. The annual yield potential of growing stock volume, not including thinnings, is about 38 cubic feet per acre. The potential yield on growing stock, which represents about 83 percent of 2.4 million acres of commercial timber, would be about 75 million cubic feet annually.

The noncommercial portion of the forest is predominantly pinyon pine and juniper. It also includes species that presently have little commercial value, not economically available, and timber lands withdrawn from utilization through statute, ordinance, or administrative order. There are about 5.6 million acres of noncommercial forest lands.


LEGEND
Commercial Forest
Woodland (Pinyon - Juniper)
Brushland
Bottomland Vegetation
Grassland
Cropland (Irrigated & Dry)
Previously Cropped Land Not Well- Revegetated
NEW MEXICO
RIO ARRIBA
LOS ALAMOS
SANDOVAL
SANTA FE
MC KINLEY
BERNALILLO
ALBUQUERQUE
VALENCIA
TORRANCE
CATRON
SOCORRO
SIERRA
SAN AGUSTIN PLAINS
RIO GRANDE
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
VEGETATION MAP
UPPER RIO GRANDE BASIN
NEW MEXICO
Miles
LEGEND
Basin Boundary
County Boundary
State Boundary
Road
Town
County Seat
Reservoir and Lake
JULY 1970

M7-S-21631-N

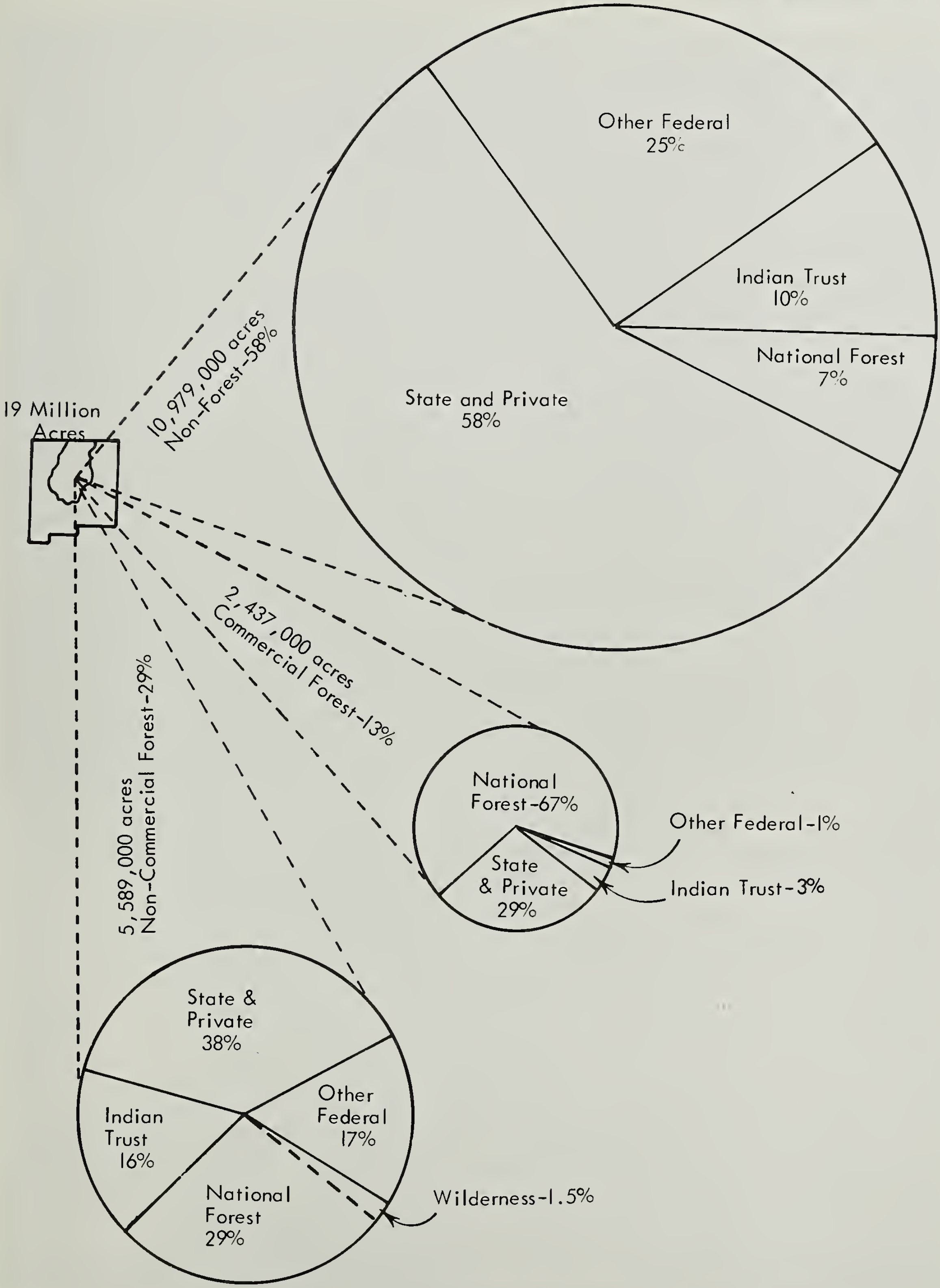


FIGURE III-2. OWNERSHIP FOREST AND NON-FOREST AREA, UPPER RIO GRANDE BASIN, NEW MEXICO

WOODLAND (PINYON AND JUNIPER)

The pinyon-juniper type woodlands occur at elevations between 4,500 and 7,500 feet and generally occupy an area below the ponderosa pine belt. The principal species include one-seeded juniper, Utah juniper, pinyon pine, alligator juniper, and Rocky Mountain juniper. The principal grasses that make up the understory are sideoats grama, mutton grass, blue grama, galleta, three-awn grass, Arizona fescue, and squirreltail. The understory may at times include Gamble oak, bitterbrush, mountain mahogany, and cliff rose.

BRUSHLAND

Brushland includes vegetation associated with mountain brush (Chaparral), Northern Desert shrub, and Southern Desert shrub. Mountain brush is usually located on the southern aspects, steep breaks, and mesas. The species include scrub Gamble oak, liveoak, mountain mahogany, and New Mexico locust. Other common brush include greasewood, fourwing saltbush, Apache plume, and rabbitbrush. The understory species are shadscale, winterfat, snakeweed, buckwheat, and Russian thistle. Big sagebrush is the predominate plant of the Northern Desert shrub. The Southern Desert shrub is characterized by the creosote bush, catclaw, mesquite, tarbush, rabbitbrush, cholla, and prickly pear. Within the brushland areas the principal grasses include Western wheatgrass, Indian ricegrass, sideoats grama, blue grama, galleta, sacaton, sand dropseed, and needle and thread grass.

BOTTOMLAND

Bottomland areas are located along major water courses, floodplains, and drainageways. Some are in such narrow strips that they cannot be shown to scale on the map. They are characterized by riparian vegetation. The dominant plants in this resource area are saltcedars, cottonwood, and willow at the lower elevations; with alder, ash, and locust occurring at the higher elevations. The understory is dominated by saltgrass, sedges, and bluegrasses.

GRASSLAND

Grassland encompasses all grass communities ranging from alpine to desert environments. Alpine areas are limited to the short grasses and sedges, because it is not unusual to have frost at any time of the year in this environment. Other grasslands generally have short grass communities comprised of many species, depending on the diversity of the sites. The principal species include blue grama, sideoats grama, Western wheatgrass, big bluestem, little bluestem, Indian ricegrass, lovegrass, sand dropseed, tobosa, black grama, Arizona fescue, June grass, Mountain muhly, and needle grass.

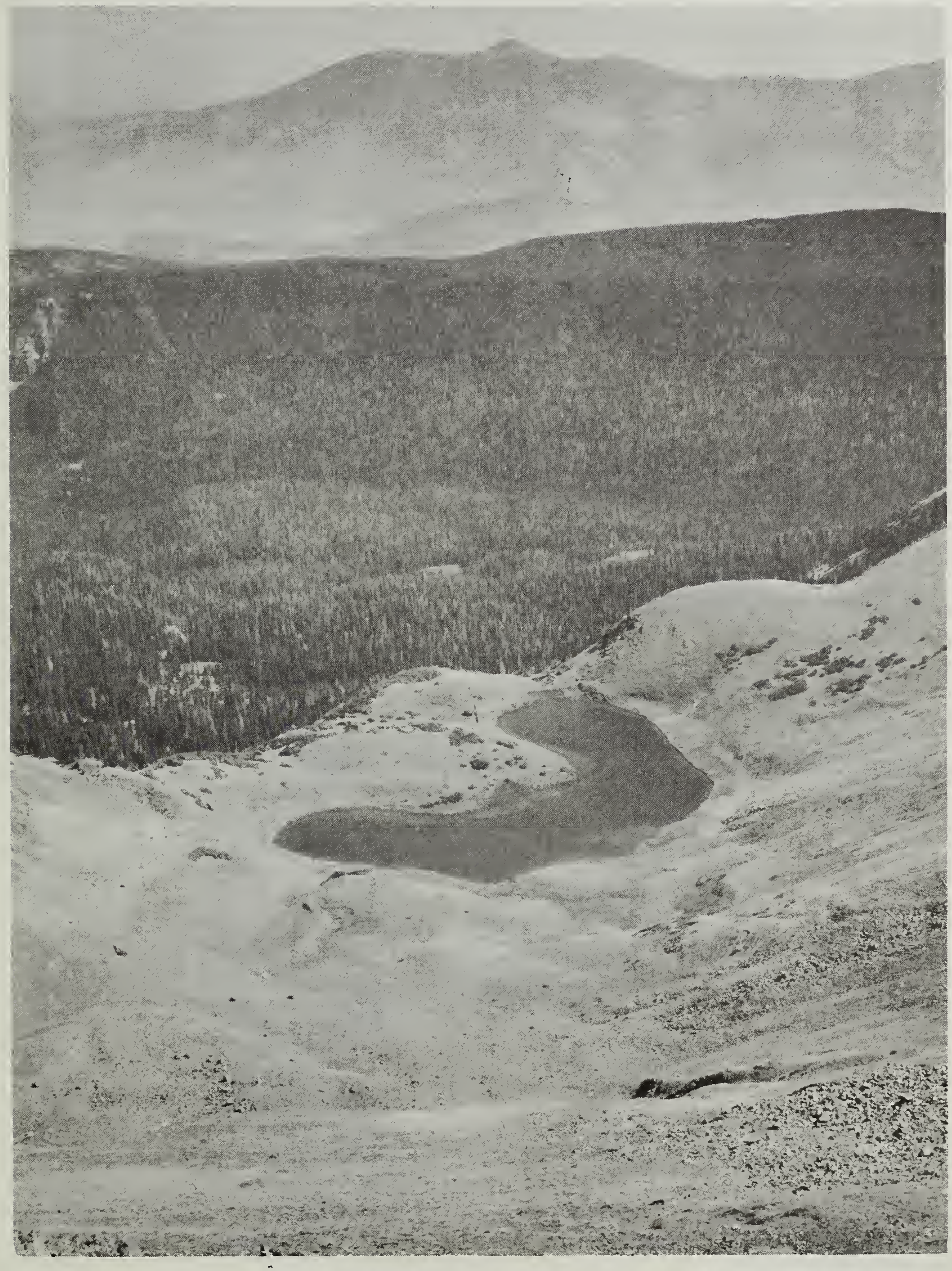


Photo III-9. Pecos Wilderness, Carson National Forest, New Mexico

US FOREST SERVICE PHOTO

CROPLAND (IRRIGATED AND DRY)

Cropland,as shown on the Vegetation Map, indicates the areas of cultivated vegetation. The vegetation includes hay (principally alfalfa), corn, wheat sorghum, cotton, vegetables, and orchards.

PREVIOUSLY CROPPED LAND - NOT WELL REVEGETATED

Previously cropped land is also shown on the Vegetation Map to indicate land in transition--land not farmed and producing less than half of its potential because it has not been reseeded or otherwise revegetated.

L A N D   U S E

Lands in the basin are used in many ways. The vast, open grasslands and forest lands support wildlife, recreation, watersheds, etc. Some uses are nearly exclusive such as urban, crop production, highways, and recreation development. The current emphasis in land use planning and management is utilization of the various resources in a combination that strikes a balance between providing goods and services and maintaining the values of environmental quality and social well-being.

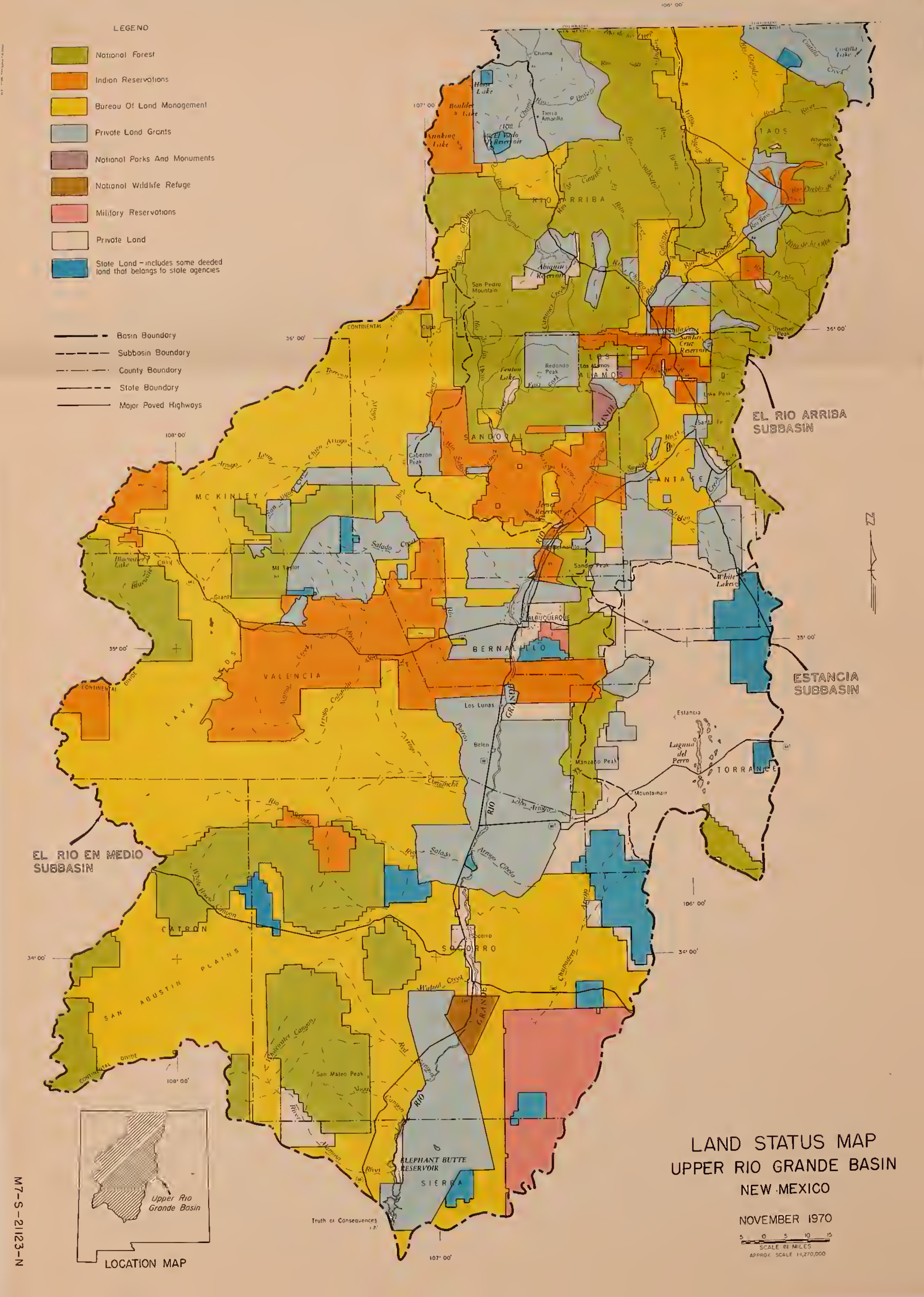
CROPLAND

Nearly 350,000 acres of the basin are cropland, of which 221,000 acres have been developed for irrigation. Irrigated lands are generally developed along major streams where suitable water is available. There is some pump irrigation near Estancia. Irrigation systems range from primitive to modern. Grazing of livestock on crop aftermath is a common practice. Other uses of cropland include wildlife habitat, recreation, and hunting.

Non-irrigated cropland generally occurs along the eastern side of the basin. Small tracts of dry farming also occur in the mountain foothills up to elevations of about 7,500 feet. Limitations on dry farming include erratic precipitation and the few choices of adapted and profitable crops.

RANGELAND

The predominate use of rangeland is grazing of the native forage by wildlife and domestic livestock. There are variations in the capacity of the land because of differences in precipitation, elevation, topography, soil, and vegetation type. Some areas cannot be grazed because of rough topography, dense timber and brush, barren lands, and lack of water development.


LEGEND
National Forest
Indian Reservations
Bureau Of Land Management
Private Land Grants
National Parks And Monuments
National Wildlife Refuge
Military Reservations
Private Land
State Land - includes some deeded land that belongs to state agencies
Basin Boundary
Subbasin Boundary
County Boundary
State Boundary
Major Paved Highways
EL RIO ARRIBA SUBBASIN
ESTANCIA SUBBASIN
EL RIO EN MEDIO SUBBASIN
TAOS
RIO ARRIBA
LOS ALAMOS
SANDOVAL
SANTA FE
MC KINLEY
BERNALILLO
VALENCIA
TORRANCE
CATRON
SOCORRO
SIERRA
SAN AGUSTIN PLAINS
LAVA BEDS
Albuquerque
Grants
Los Lunas
Belen
Estancia
Mountainair
Socorro
Truth or Consequences
Elephant Butte Reservoir
Laguna del Perro
Mt Taylor
Redondo Peak
Sandia Peak
Manzano Peak
Lake Peak
San Pedro Mountain
Cabezon Peak
San Mateo Peak
Rio Grande
Rio Puerco
Rio Salado
Rio Chama
Continental Divide
LAND STATUS MAP
UPPER RIO GRANDE BASIN
NEW MEXICO
NOVEMBER 1970
SCALE IN MILES
APPROX. SCALE 1:1,270,000
LOCATION MAP
Upper Rio Grande Basin
M7-S-21123-N

Forage growth usually follows periods of precipitation. This growth occurs in two periods--in the spring (February and March); and in mid-summer (July and August). The most critical periods of water shortage, however, occur in May and June and September and October. The spring growth is from winter moisture and possible spring showers.

There are approximately 18.5 million acres of land grazed, which provide 2.8 million animal unit months. The public-owned lands (state, BLM, Defense, National Forest) account for 9.3 million acres of grazable land. The grazing capacity of these lands is about 1.5 million animal unit months. The present livestock population ranges from 175,000 to 241,000 animal units yearlong. The average animal units for the rangeland is about 208,000 AU's, which produce and maintain about 70 million pounds of red meat (live weight).

Land suitable for livestock use will sustain the range livestock industry under proper management and will remain an important part of the basin's economy. The land and the vegetative cover can be improved through using livestock management techniques and intensive management of the rangeland resources.

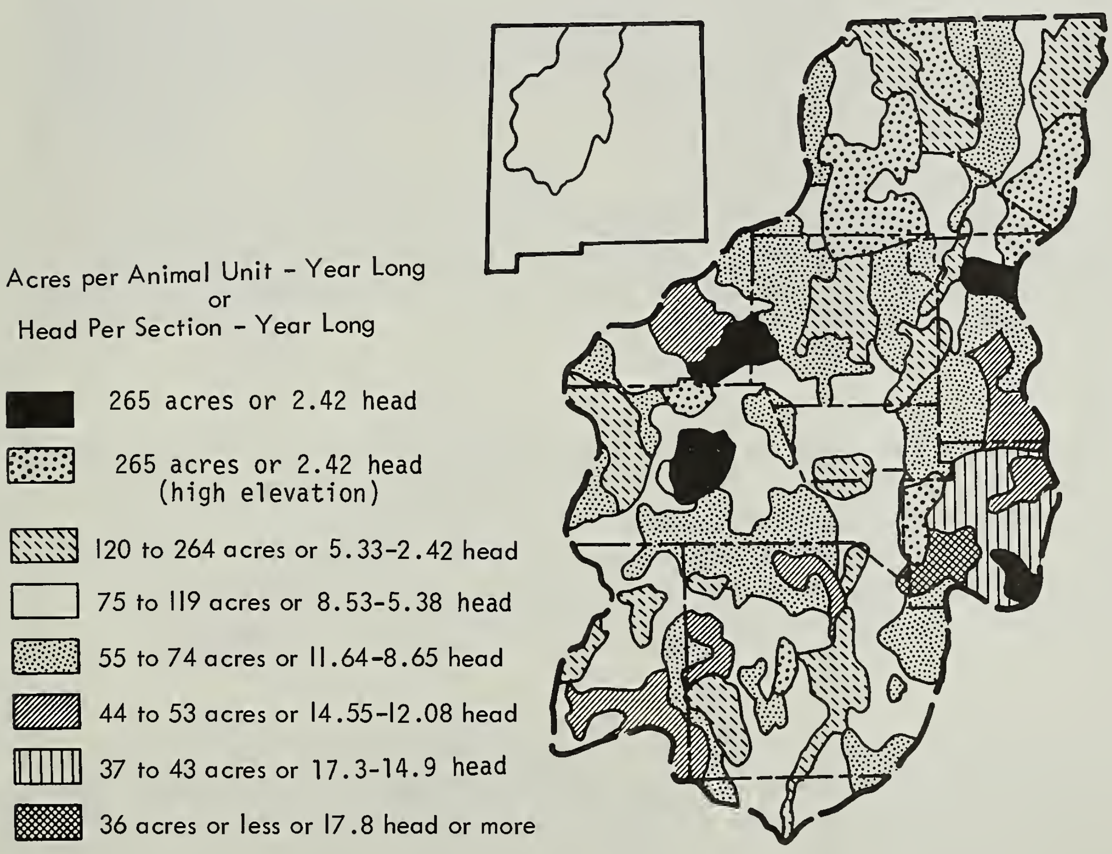


FIGURE III-3. GRAZING CAPACITY MAP UNDER AVERAGE RAINFALL AND MANAGEMENT CONDITIONS (NMSU AGRICULTURAL EXPERIMENT STATION RESEARCH REPORT 158, 1969)

FOREST LAND

There are 8 million acres of forest land in the basin. In general, forests occupy areas at elevations in excess of 6,500 feet. The forest lands have outstanding values for water, recreation, livestock grazing, timber products, and wilderness. Wood products derived include sawlogs, poles, mine props, excelsior, Christmas trees, ornamentals, firewood, and fence posts.

One-third of the forest land (2.4 million acres) is classed as commercial timber type. It is estimated that this acreage contains 8.2 billion board feet of harvestable lumber. Ponderosa pine is the most valuable species and is harvested exclusively for sawlog production. Commercial timber type lands are found in the Sangre de Cristo, Jemez Mountains, Mt. Taylor, Manzano, Sandia, and San Mateo Mountain areas. Coniferous forests in these areas have high aesthetic, recreation, and other environmental values.

The non-commercial portion of the forest land amounts to about 5.6 million acres. Included in these areas are species that now have little commercial value; timberlands withdrawn from utilization through statute, ordinance, or administrative order; and areas of coniferous types growing under adverse conditions or not economically feasible to harvest at this time. Pinyon pine and juniper are the predominate species in the non-commercial area.

URBAN BUILD UP

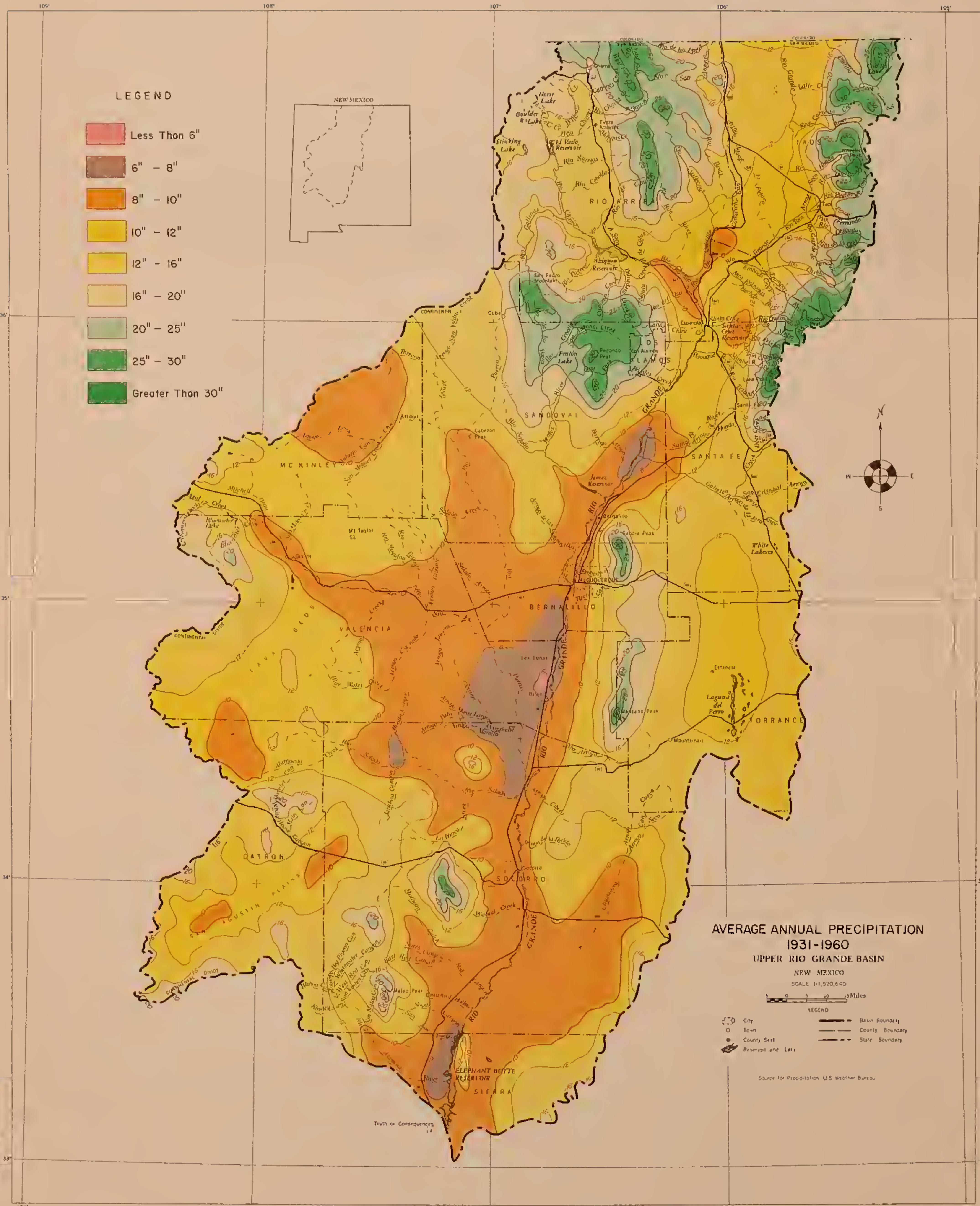
Urban development occupies approximately 280,800 acres. Individual development ranges from small villages to the 80,000 acres of metropolitan Albuquerque. Included in urban uses are residential, business, and some industrial developments.

DEFENSE

Land use by the military is associated with installations in Albuquerque and a portion of the White Sands Missile Range, which is the largest defense area in the basin and serves as a testing area for military weapons. Most of the land is semiarid mountain and desert. Portions of the area are open to livestock grazing and special big game hunts. The land used for this purpose is 531,000 acres.

ROADS

The land used for road systems in the basin amounts to 122,100 acres. The major interstate freeways have brought changes in land use. Favorable climatic conditions are a factor in attracting traffic for both private and commercial uses. Interstate highways have reduced travel time to recreation areas.


LEGEND
Less Than 6"
6" - 8"
8" - 10"
10" - 12"
12" - 16"
16" - 20"
20" - 25"
25" - 30"
Greater Than 30"
NEW MEXICO
AVERAGE ANNUAL PRECIPITATION
1931-1960
UPPER RIO GRANDE BASIN
NEW MEXICO
RIO ARRIBA
SANDOVAL
LOS ALAMOS
SANTA FE
McKINLEY
BERNALILLO
VALENCIA
TORRANCE
CATRON
SOCORRO
SIERRA
RIO GRANDE
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
Source for Precipitation U.S. Weather Bureau

M7-S-21635-N

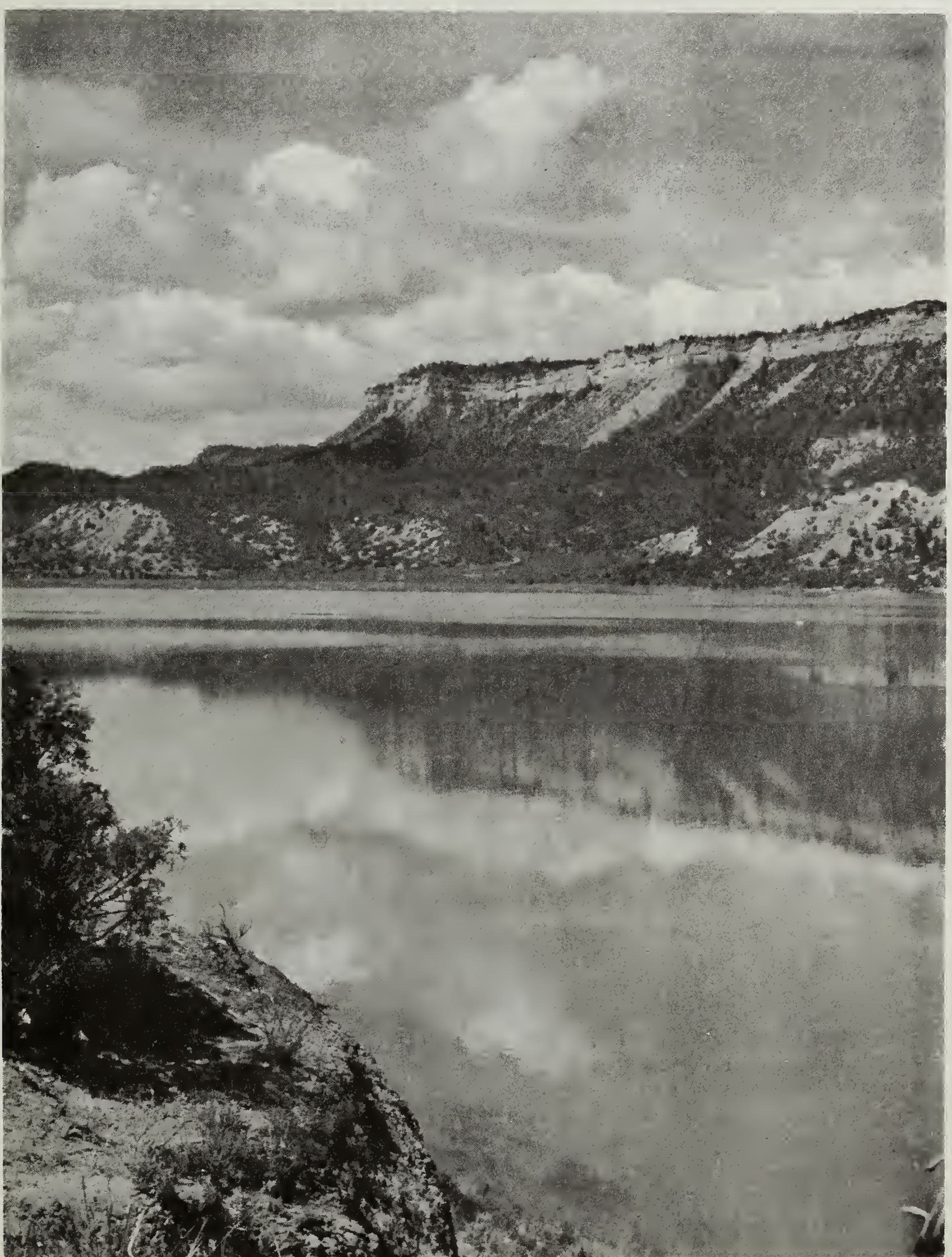


Photo III-10. El Vado Reservoir, New Mexico

NEW MEXICO STATE PARK SERVICE PHOTO

OUTDOOR RECREATION

Nearly all of the land is used for some form of recreation. Recreation activities include hiking, sightseeing, pleasure driving, camping, picnicking, rockhounding, hunting, fishing, and winter sport activities. Outdoor recreation is available year-round. The most valuable areas are generally those having special attraction such as rivers, streams, lakes, and reservoirs, coniferous forest, and unusual archeological, historical, geological, or scenic values.

INLAND WATERS

Inland water areas comprise 47,600 acres and include lakes and reservoirs with 40 surface acres or more. Natural lakes located in the higher forested areas make up a small percentage of the acreage. The major streams are all controlled by reservoirs that are used for water-oriented recreation. Elephant Butte Reservoir, the largest reservoir in the basin, makes up 76 percent of the water surface acres. There are other numerous small impoundments, mostly for livestock watering, scattered throughout the basin.

PARKS AND REFUGES

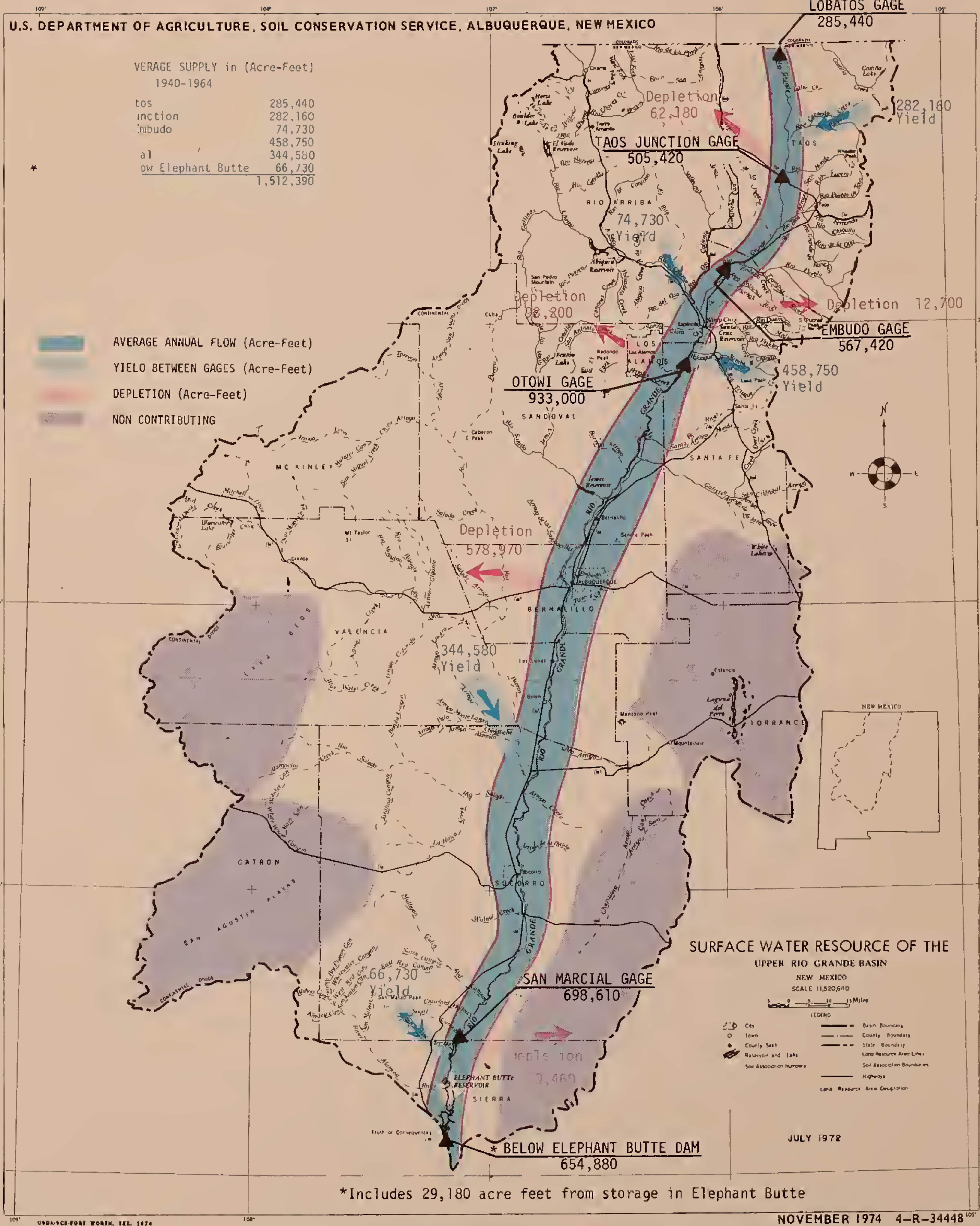
Included are state and national parks and lands administered by organizations in the federal and state governments. They are used primarily for recreation with emphasis on the preservation of the various resources. There are 170,400 acres of this category.

WATER RESOURCES

SURFACE WATER

The average annual precipitation is about 13.2 inches of water over the entire area or about 20,896,000 acre-feet. About 654,880 acre-feet (of which 285,400 acre-feet is inflow from Colorado) leave the basin at Elephant Butte Dam as streamflow. An annual average of 857,510 acre-feet are consumed by identifiable uses (see Table III-4, page III-21). The remainder is consumed by vegetation or lost through evaporation. The Average Annual Water Yield Map gives details on water yield. The Surface Water Resource Map, facing page III-20, shows depletions (1969) and average annual water supply based on 1940-1964 records.

About 7,760 square miles are non-contributing to surface runoff due to natural lakes and topographically closed basins (Estancia, Jornada, and San Augustin).


U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO
VERAGE SUPPLY in (Acre-Feet)
1940-1964
tos 285,440
inction 282,160
mbudo 74,730
458,750
al 344,580
ow Elephant Butte 66,730
1,512,390
AVERAGE ANNUAL FLOW (Acre-Feet)
YIELD BETWEEN GAGES (Acre-Feet)
DEPLETION (Acre-Feet)
NON CONTRIBUTING
LOBATOS GAGE
285,440
Depletion
62,180
282,160
Yield
TAOS JUNCTION GAGE
505,420
74,730
Yield
Depletion
98,200
Depletion 12,700
EMBUDO GAGE
567,420
OTOWI GAGE
933,000
458,750
Yield
Depletion
578,970
344,580
Yield
66,730
Yield
SAN MARCIAL GAGE
698,610
* BELOW ELEPHANT BUTTE DAM
654,880
RIO ARRIBA
SANDOVAL
SANTA FE
MC KINLEY
VALENCIA
BERNALILLO
TORRANCE
CATRON
SOCORRO
SIERRA
TAOS
LOS ALAMOS
SAN AGUSTIN PLAINS
ELEPHANT BUTTE RESERVOIR
SURFACE WATER RESOURCE OF THE
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
JULY 1972
*Includes 29,180 acre feet from storage in Elephant Butte
USDA-SCS-FORT WORTH, TEX. 1974
NOVEMBER 1974 4-R-34448

Average annual streamflow (1900-1964) of the Rio Grande at Otowi gage was about 1,126,000 acre-feet; at the Embudo gage the flow was about 739,000 acre-feet. The 25-year average (1940-1964) was 933,000 acre-feet at Otowi gage and 567,450 acre-feet at Embudo. This is a reduction in flow at Otowi of about 17 percent and at Embudo of about 23 percent. The average annual flow at San Marcial was 698,610 acre-feet for the 1940-1964 period (Surface Water Resource Map, facing page III-20). From long-term records (1900-1964) the average annual flow at San Marcial was 931,958 acre-feet. The 1940-1964 average streamflow was about 26 percent less than the long-term average.

Tables III-4 and III-5 show estimated water supply and depletions (1969). Table III-4 is a detailed breakdown of water depletion by use. Table III-5 shows the water supply by tributary and outflow at stream gages on the mainstem of the Rio Grande.

TABLE III-4. ESTIMATED ANNUAL SURFACE WATER DEPLETION BY IDENTIFIABLE USE, UPPER RIO GRANDE BASIN, NEW MEXICO

Use	Percent
Irrigation	34
Phreatophytes and Wetted Sands	45
Evaporation from Reservoirs	12
Municipal and Industrial	4
Domestic Recreation and Wildlife	5
TOTAL	100

TABLE III-5. SUMMARY OF ESTIMATED WATER SUPPLY, UPPER RIO GRANDE BASIN, NEW MEXICO 1/, 1940-1964

River-reach	Inflow (Main Stem)	Tributary (Inflow)	Outflow
Lobates - Taos Junction	285,440	282,160	505,420
Taos Junction - Embudo	505,420	74,730	567,450
Embudo - Otowi	567,450	458,750	933,000
Otowi - San Marcial	933,000	344,580	698,610
San Marcial - Elephant Butte Dam	698,610	66,730	654,880 2/
		1,226,950	

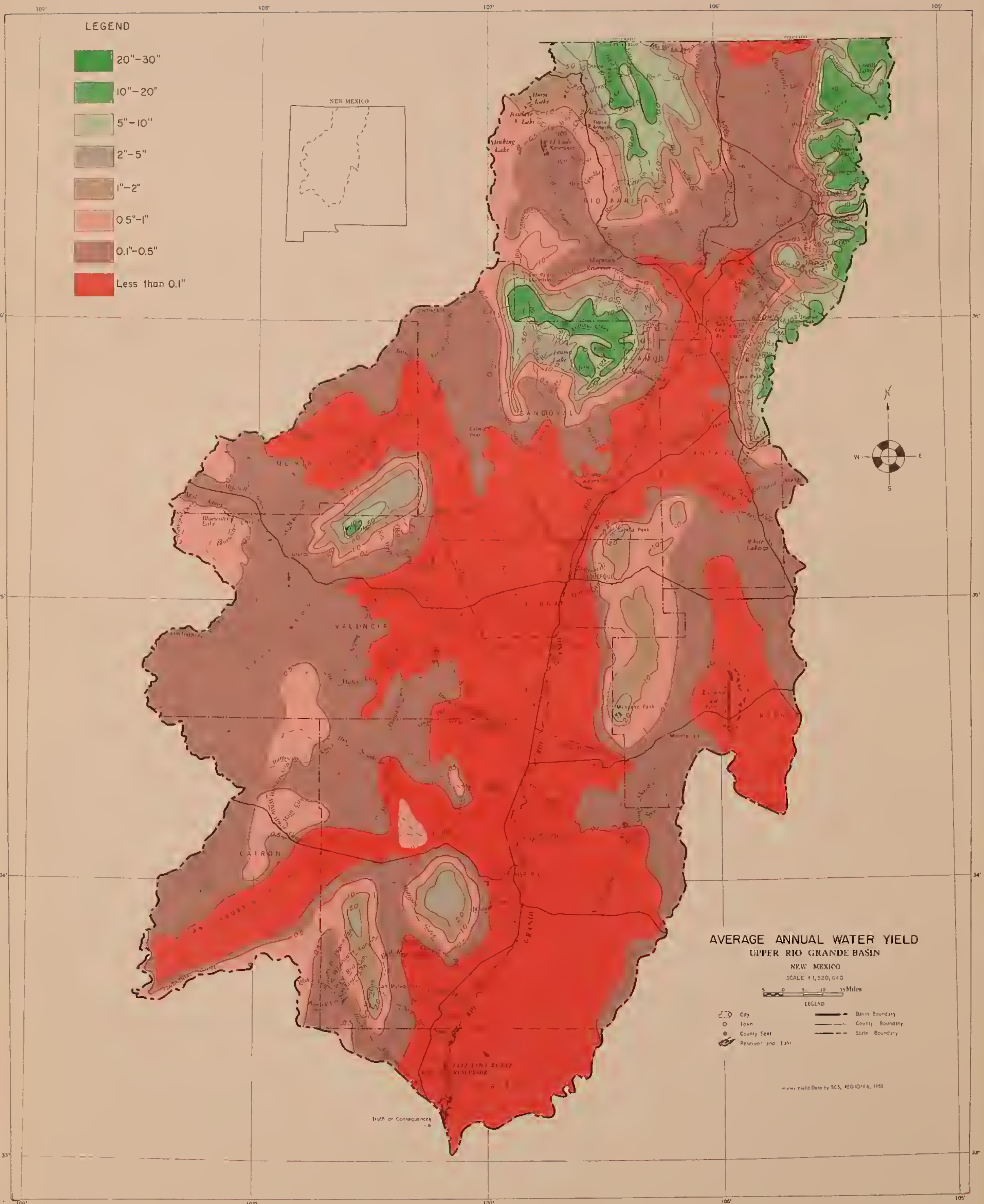
1/ Includes estimated tributary yields and ground water accretion to Rio Grande.

2/ Includes 29,360 acre-feet from storage in Elephant Butte Reservoir.

NOTE: Inflow and Outflow are from gage record.

PHOTO III-11. SNOW PACK CONTRIBUTES TO SUMMER WATER SUPPLY

US FOREST SERVICE PHOTO



LEGEND
20"–30"
10"–20"
5"–10"
2"–5"
1"–2"
0.5"–1"
0.1"–0.5"
Less than 0.1"
NEW MEXICO
AVERAGE ANNUAL WATER YIELD
UPPER RIO GRANDE BASIN
NEW MEXICO
Miles
LEGEND
City
Town
County Seat
Basin Boundary
County Boundary
State Boundary
Truth or Consequences

M7-S-21632-N

GEOGRAPHICAL AND SEASONAL DISTRIBUTION OF WATER

Areas with high mountain watersheds yield much more to streamflow than do areas of lower elevations. Some of the high yielding areas are the Rio Chama headwaters above La Puente, the Santa Cruz River above Cundiyo, the Vallecitos and Tusas Rivers above La Madera, and the Sangre de Cristo Mountains on the east boundary of the basin. Runoff is high in the spring and low the rest of the year.

Streamflow records show that about 67 percent of the average annual streamflow occurs during the months of April, May, and June. By the end of June, 83 percent of the runoff has occurred. Figure III-4, page III-21, shows average monthly distribution in percent of the average annual streamflow. Runoff during June, July, August, and September averages about 28 percent of the average annual streamflow.

GROUND WATER

Aquifers in the basin may be separated into two general groups--valley fill and bedrock. The following is quoted from George A. Dinwiddie (1967):

"Valley fill includes sediments that have been deposited along tributary streams and have filled the Rio Grande trough. Valley fill aquifers in this basin generally are stream-connected and are recharged mainly from streamflow. The Rio Grande trough is filled with silt, sand, gravel, and conglomerate which is unconsolidated to moderately consolidated (Conover, 1954: Speigel, 1963). The deposit is very thick (as deep as 9,000 feet) and is the most reliable aquifer for large quantities of water in the basin. (Bjorklund, 1961). The yield of water at 83 large discharge wells in the Albuquerque area ranges from 240 to 2,000 gpm (gallons per minute) and average 860 gpm. The valley fill along the Rio San Jose yields about 10 to 100 gpm, and wells in valley fill along the Pojoaque River in Santa Fe County may yield from less than 10 to more than 800 gpm.

Bedrock aquifers in the Rio Grande basin may be composed of sandstone, conglomerate, or limestone. Generally, beds of shale, mudstone, silt-stone, or clay yield little or no water directly to wells. Lava flows may yield moderate amounts of water to wells at places where the flow is saturated and where fractures may be tapped.

The amount of water in storage in valley fill in the Rio Grande Basin in New Mexico cannot be computed accurately with available data; however, a general estimate was made using some assumed storage characteristics. The estimated average coefficient of storage of the valley fill in the Albuquerque area is 0.2 (Bjorklund, 1961)."

The Generalized Depth to Ground Water Map, facing page III-24, indicates areas where ground water should be encountered at depths of less than 200 feet, 200 to 500 feet, and at depths greater than 500 feet. This map should not be used for specific well locations. It is a generalized guide of what is in the basin relative to ground water availability.

Ground water resources vary throughout the basin as a result of variation in rock types and permeability. The presence or absence of confining layers above and below aquifers, lenticularity or extent of aquifers, steepness of aquifer, outcrop in recharge area, size of recharge area, amount of dissection by erosion, and structural features are some of the factors that influence ground water resources.

There is a scarcity of data available over much of the area. Many sources have been used to compile the "Generalized Depth to Ground Water Map". Due to the variability of factors affecting ground water resources, detailed studies and investigations will be needed to evaluate ground water resources for a specific area of development.

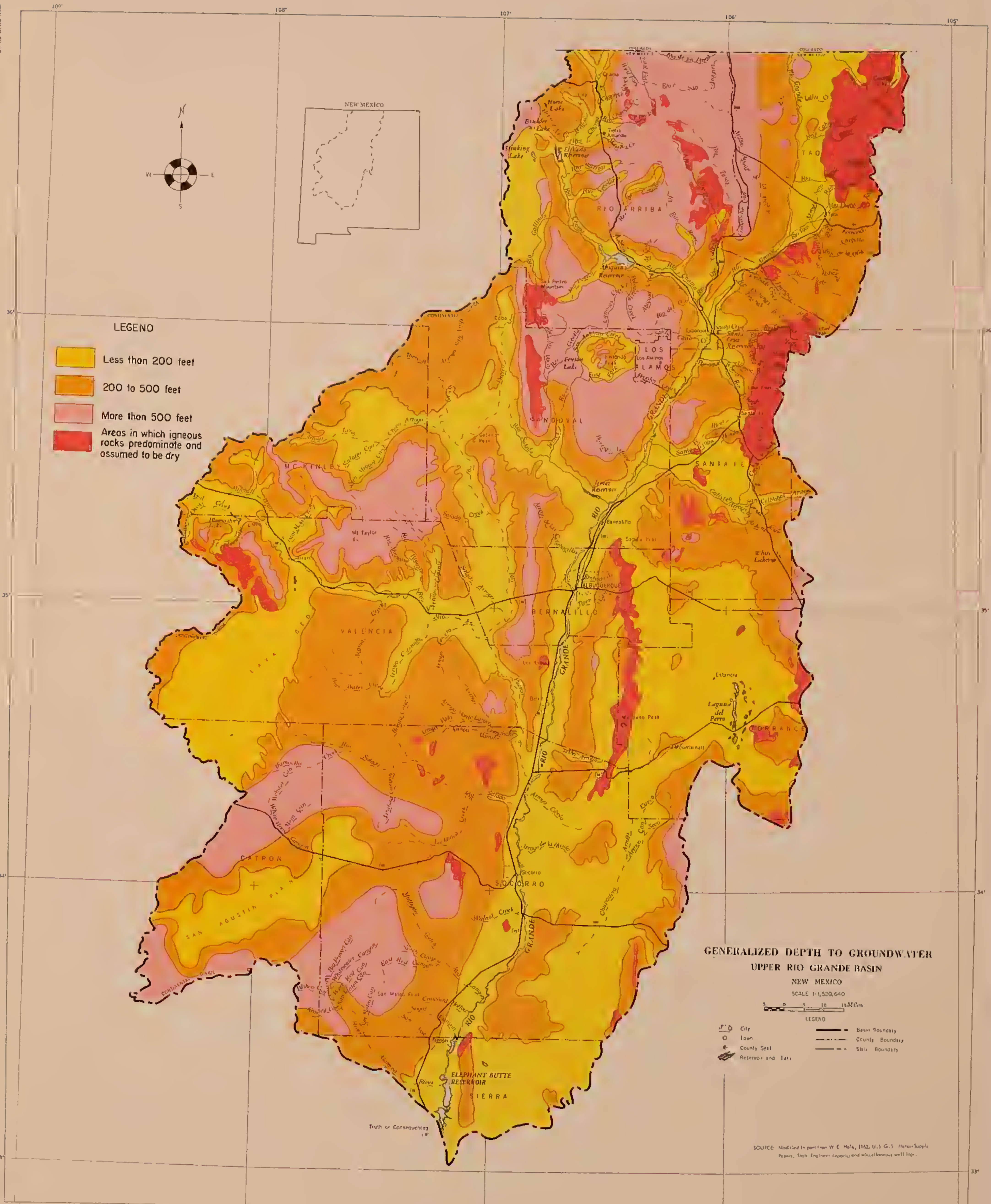
In the Estancia Subbasin ground water levels are declining in the pumped area. A maximum decline of 40 feet occurred during the 1948-1965 period. Three aquifers supply water for irrigation. The principal aquifer is the Tertiary and Quaternary valley fill. The Madera Limestone and Glorieta Sandstone members of the San Andres Formation are the other two aquifers. In 1969, there were about 46,200 acre-feet of water depletion in the Estancia Subbasin; 32,400 acre-feet for irrigation, 1,100 acre-feet for domestic livestock and recreation, 12,700 acre-feet for evaporation.

THERMAL WATER

Thermal water anomalies occur along the Rio Grande throughout the basin. Some developments (wells and springs) have occurred, but essentially the thermal waters are an untapped resource. Thermal waters may occur as springs or at depths of more than 6,000 feet. Yields may range from 2 to 1,500 gallons per minute, and temperatures from 90 degrees F. to 400 degrees F. (Summers, 1965)

WATER QUALITY

Both surface water and ground water are generally suitable for agricultural purposes. The general occurrence of saline ground water is shown in Figure III-5, page III-28. Slightly saline water (containing 1,000 to 3,000 parts per million total dissolved solids) can be used for drinking, irrigation, and industrial purposes (Hale, Reiland, and Beverage, 1965). Under certain conditions, water classed as moderately saline (3,000 to 10,000 ppm) may be used for some industry and in irrigation (Hale, Reiland, and Beverage, 1965). There is a salinity increase of river water between Otowi Bridge and Elephant Butte Reservoir.



GENERALIZED DEPTH TO GROUNDWATER
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
LEGEND
Less than 200 feet
200 to 500 feet
More than 500 feet
Areas in which igneous rocks predominate and assumed to be dry
City
Town
County Seat
Basin Boundary
County Boundary
State Boundary
NEW MEXICO
RIO ARRIBA
SANDOVAL
LOS ALAMOS
SANTA FE
McKINLEY
VALENCIA
BERNALILLO
TORRANCE
CATRON
SOCORRO
SIERRA
RIO GRANDE
ALBUQUERQUE
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
Socorro
Estancia
Laguna del Perro
Mt Taylor
Bernalillo

TABLE III-6. ANALYSES OF WATER FROM SELECTED WELLS IN THE RIO GRANDE BASIN, NEW MEXICO

Aquifer and Location	Sul-phate (ppm)	Chlo-ride (ppm)	Conductance (micromhos at 25°C)	Total hard-ness (as $CaCO_3$, ppm)
Alluvium in Sunshine Valley north of Questa	43	18	190	98
Santa Fe Group near Santa Fe	30	8	354	150
Santa Fe Group near Albuquerque	111	17	556	108
San Andres Limestone near Grants	380	80	1,460	613
Ojo Alamo Sandstone west of Cuba	202	25	715	276

Source: Dinwiddie, G. A., 1967

Generally, ground water is hard but of adequate quality for domestic use. Water from deep wells is often highly mineralized but potable. Table III-6 indicates the general quality of water that is obtained from wells at a few places in the Rio Grande Basin. Table III-7, page III-27, is a summary of chemical-quality from station records for streams in the basin.

WATER USE

The principal use of water is for native vegetation. Other than native range and forest, phreatophytes and wetted sands are the highest users of water (45 percent of that identifiable).

At the present time, several uses are made of the water within the basin. Table III-4, page III-21, shows the identifiable depletions of surface water.

Pumping from ground water aquifer along the Rio Grande directly affects the streamflow in the river, and for purposes of this report, is considered as streamflow.

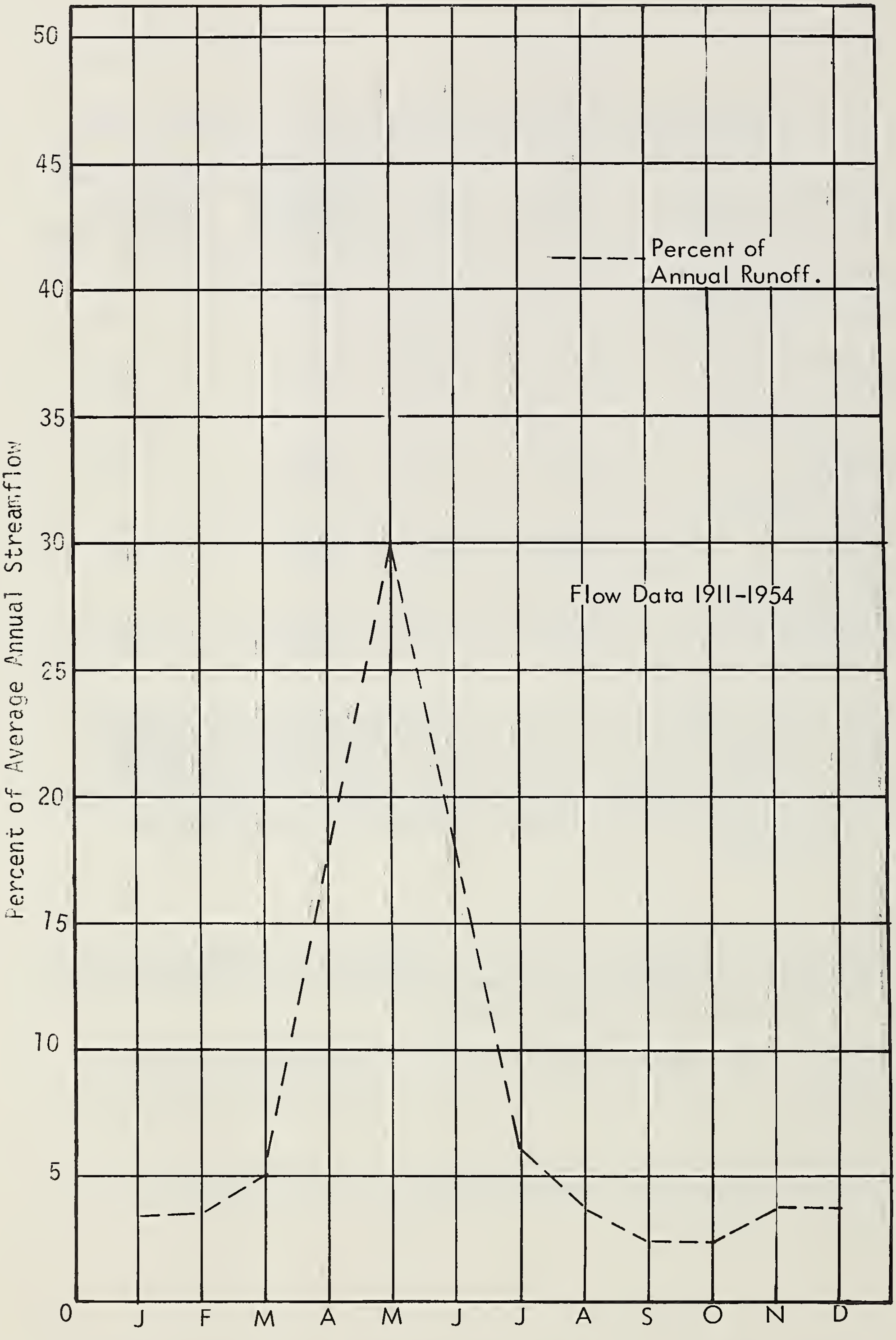


FIGURE III-4. TYPICAL SEASON STREAMFLOW DISTRIBUTION BY MONTH (PERCENT)

TABLE III-7. SUMMARY OF CHEMICAL-QUALITY STATION RECORDS FOR STREAMS IN THE RIO GRANDE BASIN, NEW MEXICO

(Period of Record - Water Years 1930, 1940, 1950, 1960)

Station	Daily Dissolved Solids Concentration (ppm) Max.	Min.	Dissolved Solids Load (tons/day) Max.	Min.
Rio Grande above Culebra Creek near Lobatos, CO	805	104	2,690	.34
Rio Grande at Otowi Bridge near San Ildefonso	884	137	4,730	93.4
Jemez River near Jemez Springs	184	117	7.6	2.8
East Fork Jemez River near Jemez Springs	133	76	4.3	1.5
Jemez River above Rio Guadalupe near Jemez	587	256	-	-
Rio Guadalupe near Jemez Springs	295	103	21	2.6
Jemez River near Jemez	459	170	-	-
Rio Grande at Albuquerque	361	119	2,130	42.4
Rio Grande near Bernardo	1,080	207	8,270	3.86
Rio Puerco near Bernardo	-	-	-	-
Rio Grande at San Acacia	2,950	183	16,100	.2
Rio Grande (Tiffany Channel) at San Marcial	1,730	220	2,840	.24
Rio Grande Conveyance Channel at San Marcial	2,010	390	4,430	.58
Rio Grande Floodway at San Marcial	1,950	233	16,400	.72
Rio Grande below Elephant Butte Dam	1,170	426	3,790	5.2

Source: New Mexico State Engineer's Office--1967

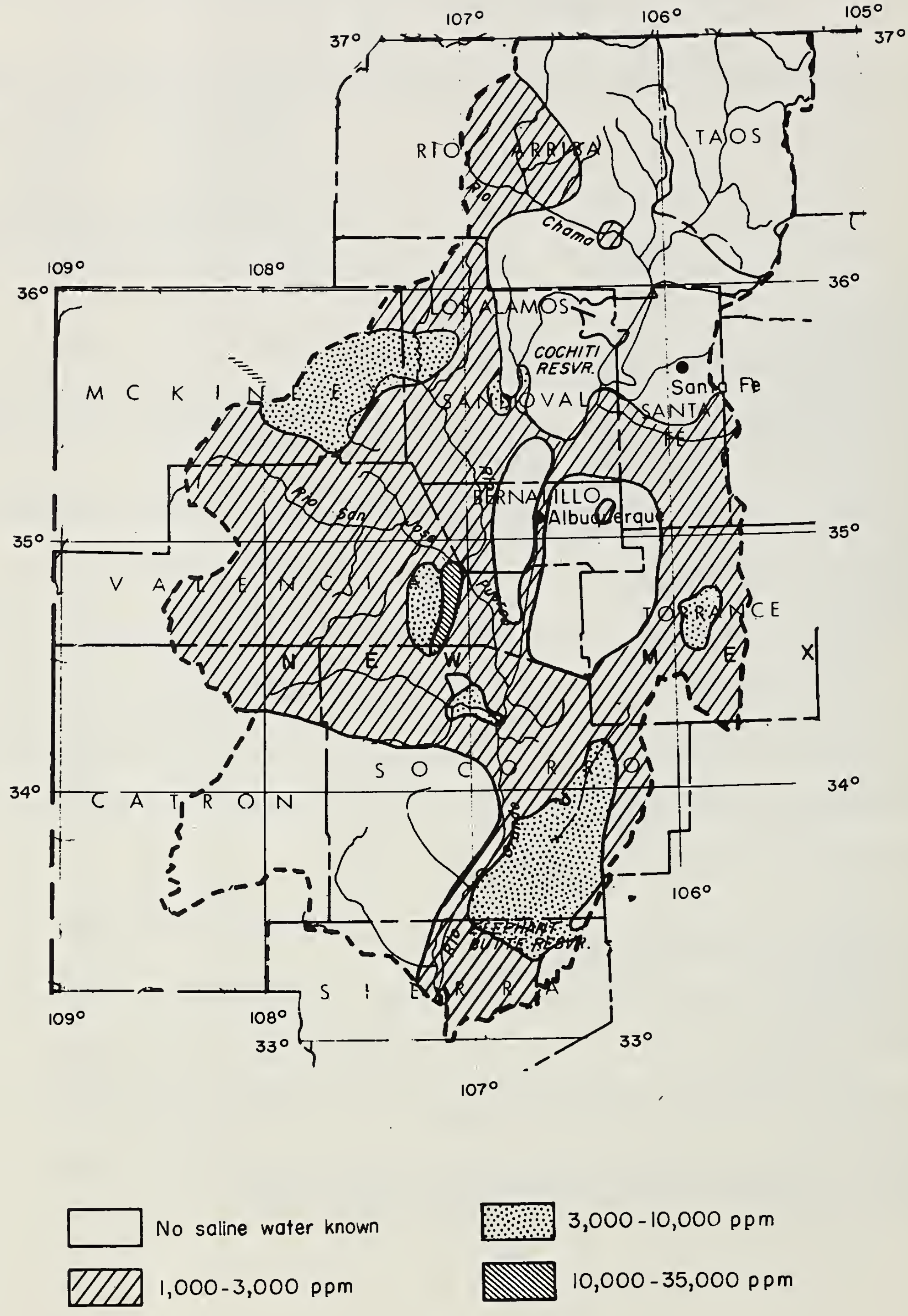


FIGURE III-5. GENERAL OCCURRENCE OF SALINE GROUNDWATER IN UPPER RIO GRANDE BASIN (FROM: HALE, W. E., REILAND, AND BEVERAGE, 1965)

WILD AND SCENIC RIVERS

The National Wild and Scenic Rivers Act (P.L. 90-542) declares ". . . certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations. The Congress declares that the established national policy of dam and other construction at appro- riate sections of the rivers of the United States needs to be comple- mented by a policy that would preserve other selected rivers or sections thereof in their free-flowing condition to protect the water quality of such rivers and to fulfill other vital national conservation purposes."

This policy was implemented by Congress by establishing the National Wild and Scenic Rivers System. Eight rivers were originally designated throughout the country. In Taos County a portion of the Rio Grande from the Colorado state line to State Highway 96 and the lower four miles of the Red River were designated as part of the system. The length of New Mexico's wild and scenic river system is 56 miles and is admin- istered by the Department of Interior's Bureau of Land Management. See the Wild and Scenic Rivers Map.

In order to qualify for Wild and Scenic designation, a river must:

1. Be substantially free-flowing.

2. Have water of high quality or water that can be restored to high quality.

3. Adjacent lands must be in natural or aesthetically pleasing condition.

4. Area must possess outstanding scenic, recreation, geologic, fish and wildlife, historic, cultural or similar values.

STREAMS WITH FREE-FLOWING VALUES

The Wild and Scenic Rivers Map indicates streams in the basin that possess the qualifications for being classified as free-flowing. Public Law 90-542, the Wild and Scenic Rivers Act, defines free-flowing as "any river or section of river that exists or flows in natural condition without impoundment, diversion, straightening, rip-rapping, or other modification of the waterway."

Free-flowing streams designated in the basin are:

1. Chama River (from El Vado Dam to Abiquiu Reservoir) - Rio Arriba County.

2. Lucero River (entire length) - Taos County.

3. Rio Brazos (from source to Chama River) - Rio Arriba County.

4. Rio de Penasco (entire length) - Taos County.

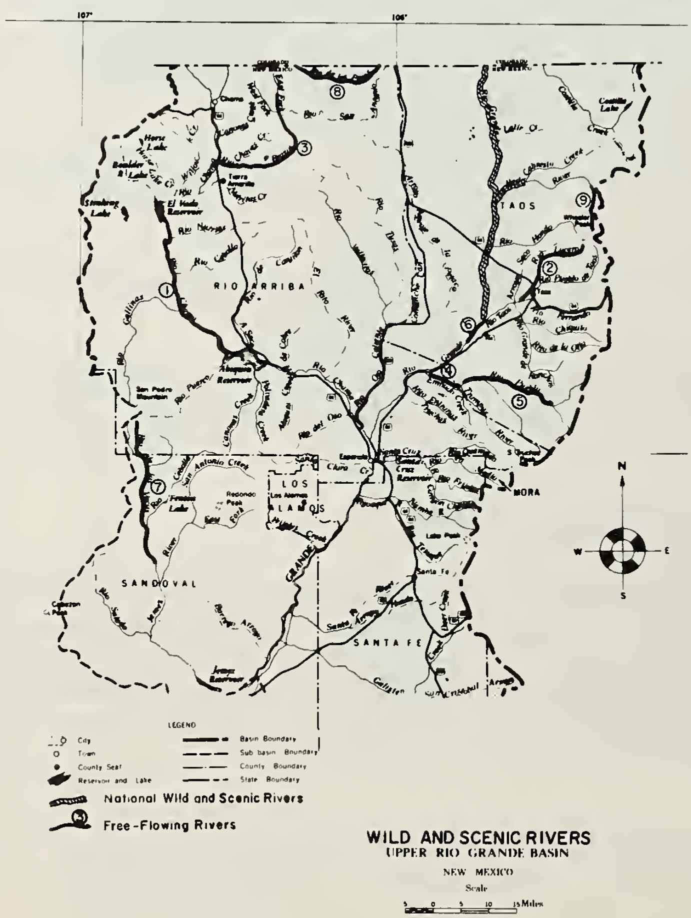
5. Rio Pueblo (entire length) - Taos County.

6. Rio Grande (from State Highway 96 bridge to Pilar) - Taos County.

7. Rio Guadalupe (from source of the Rio de las Vacas to Guadalupe Box) - Sandoval County.

8. Rio de los Pinos (entire fork) - Rio Arriba County.

9. Upper Red River (entire east fork) - Taos County.



FISH AND WILDLIFE

Major game animals are mule deer, bear, elk, bighorn sheep, and turkey. Other game includes blue grouse, antelope, pheasant, quail, and mourning dove. Fur-bearing animals include mountain lion, coyote, bobcat, badger, beaver, raccoon, mink, muskrat, skunk, pine marten, squirrel, cottontail, and jack rabbit.

There are about 1,000 miles of fishing streams and about 40,000 acres of lake waters in the basin. Cold water fish species include native cut throat, rainbow, brook, brown, Loch Leven, eastern brook trout, and Kokanee salmon. Warm water fish species include large and small mouth bass, yellow or ring perch, pike perch, bream or bluegill, crappie, and catfish. About 100 miles of drain ditches are stocked with rainbow trout in the winter time.

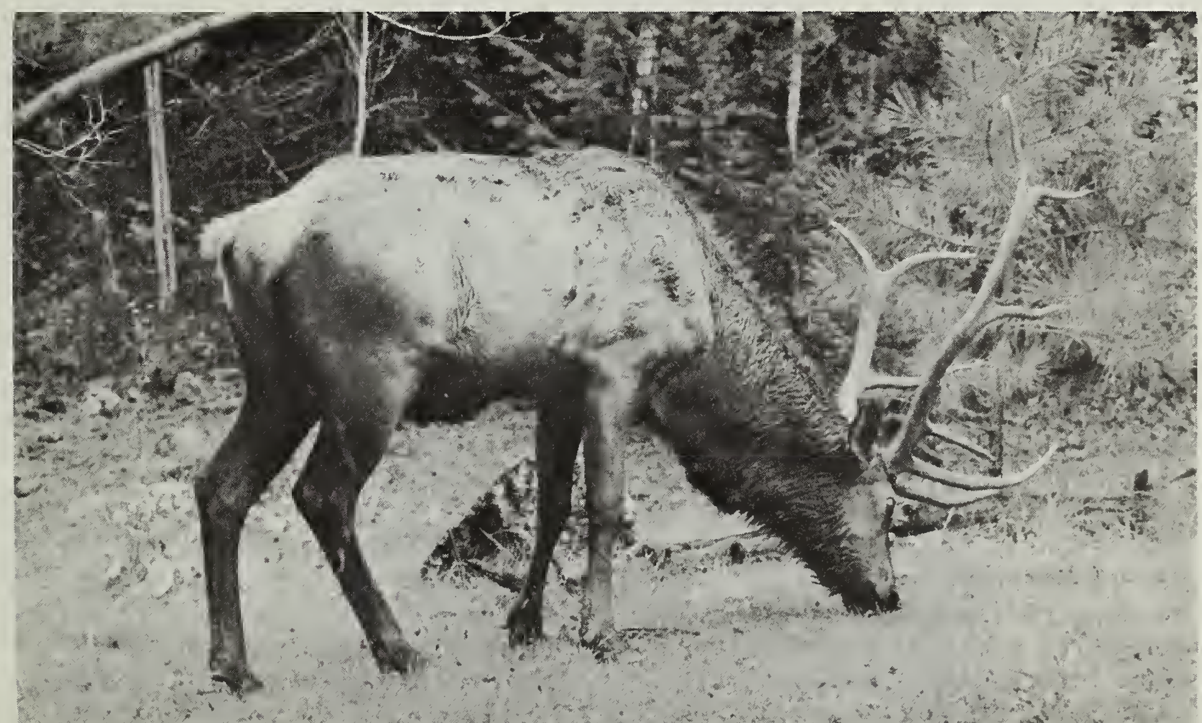


PHOTO III-12. BIG GAME OF THE FOREST SCS PHOTO

PHOTO III-13. SUCCESSFUL DAY OF FISHING SCS PHOTO 12-P845-16

SCENIC BEAUTY

Scenic beauty and climate are great assets to the basin. Clear mountain streams derived from the snow-covered mountain slopes flow through the valleys enroute to the Rio Grande. Some of the highest and most scenic mountain peaks in the state are within and adjacent to the basin. Colorful rock formations occur, particularly in the Abiqui, Cuba, and Grants areas. The Brazos Box is well known and the Brazos Falls is a spectacular sight when spring runoff pours over the cliff.

Several Indian pueblos add to the interest. The yellow and gold of the aspens in the fall are an inducement for many trips into the area during this time of year. This scene is enhanced by the bright red strings of chili that drape the sides of the houses.

The desert portion of the lower basin has its own particular charm. The desert offers a continual challenge to photographers and artists who try to capture its ever changing moods. The intensive sun penetrates a generally clear atmosphere, under low humidity conditions, to provide many interesting effects of sunlight and shadows on the sparse vegetation, various background hues of soil color, and often striking colors of the many geologic outcrops. The changing moods are generally backdropped by an intense blue sky, the silhouette of mountains and mesas, and the interesting cirrus and cumulus clouds.

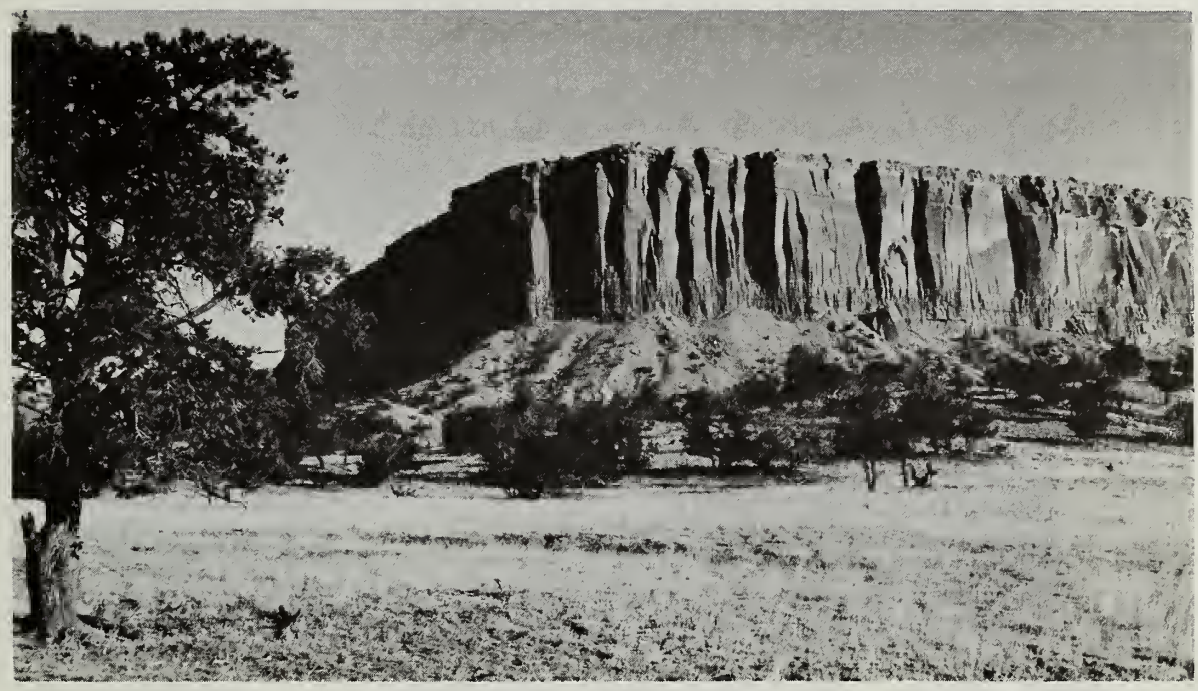


PHOTO III-14. COLORFUL SANDSTONE CLIFFS NEAR THOREAU, NEW MEXICO

SCS PHOTO 12-P935-4

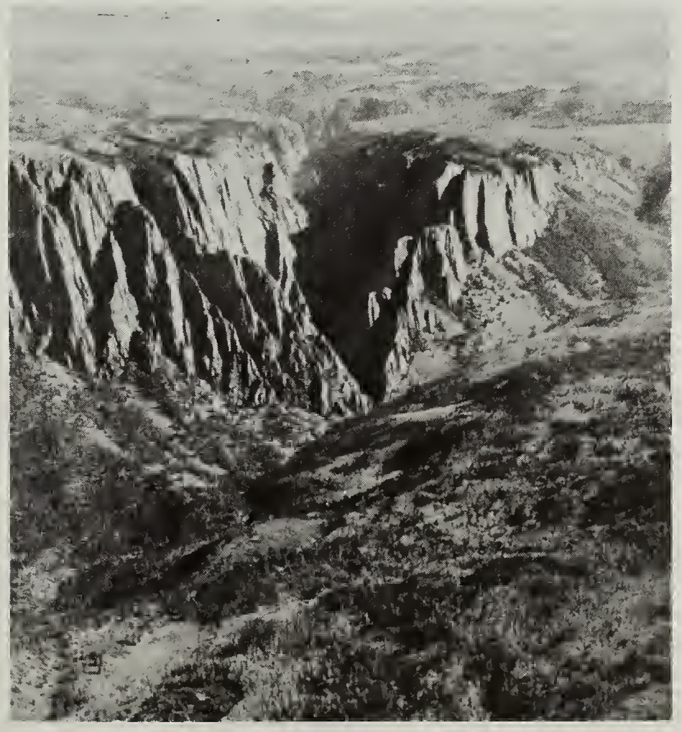


PHOTO III-15. BRAZO'S BOX, NEAR CHAMA, NEW MEXICO SCS PHOTO

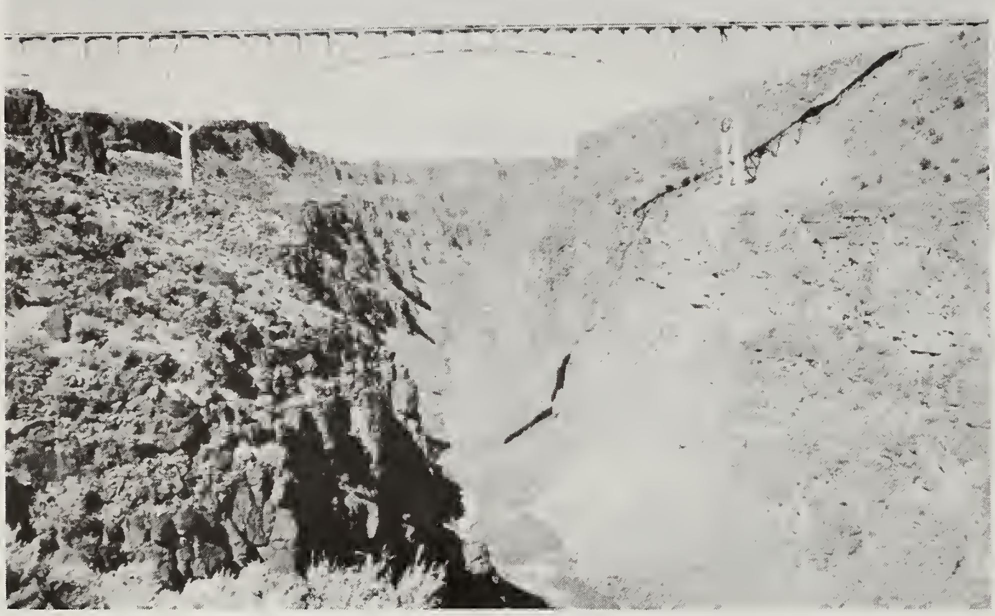


PHOTO III-16. RIO GRANDE GORGE, NEW MEXICO SCS PHOTO 12-P252-10

Bonuses of the desert are the wildlife, birds, and vegetation. Many species of animals and birds are found. The vegetation provides both a botanist's paradise and breath-taking splendor when it responds to the infrequent periods of summer rainfall.

REFERENCES

Choate, Grover A., 1966 - "New Mexico's Forest Resource", U. S. Forest Service Resource Bulletin INT-5

Dane, C. H., 1965 - Topography and Geology-Mineral and Water Resources of New Mexico; prepared by U. S. Geological Survey, State Bureau of Mines and Mineral Resources-New Mexico Institute of Mining and Technology, Bulletin 87

Dinwiddie, George A, 1967 - Geography, Geology, and Hydrology - Rio Grande Basin: Water Resources of New Mexico Occurrence, Development and Use, compiled by New Mexico State Engineer Office for State Planning Office

Fenneman, Nevin M., 1931 - Physiography of Western United States, Copyright, 131, by the McGraw-Hill Book Company, Inc.

Hale, W. E., Reiland, L. J., and Beverage, J. P., 1965 - Characteristics of the Water Supply of New Mexico, New Mexico State Engineer, Technical Report 31

New Mexico Business, 1969 - Volume 22, No. 3; Bureau of Business Research

New Mexico State Planning Office, 1967 - Water Resources of New Mexico-Occurrence, Development and Use; Santa Fe, New Mexico

New Mexico State University, Agricultural Experiment Station Research Report 158, 1969 - Grazing Capacities and Selected Factors Affecting Public Land Use

New Mexico State University, Agricultural Experiment Station Research Reports - Soil Associations and Land Classification for Irrigation

County	Report Number	Date
Catron	229	May 1972
McKinley	262	Jan. 1974
Mora	205	Sept. 1971
Santa Fe	185	Mar. 1971
Sandoval and Los Alamos	188	June 1971
San Miguel	221	Apr. 1972
Sierra	233	Sept. 1972
Socorro	234	Sept. 1972
Rio Arriba	254	May 1973
Taos	268	Jan. 1974
Torrance	187	June 1971
Valencia	267	Feb. 1974

Summers, W. K., 1965 - "Chemical Characteristics of New Mexico's Thermal Waters - a Critique", Circular 83

U. S. Department of Commerce - Environmental Services Administration - Environmental Data Service, Climatological Data, 1960-1969

____National Oceanic and Atmospheric Administration Environmental Data Services: Climatological Data 1970-1971

U. S. Geological Survey, Magnitude and Frequency of Floods; part 8 - Western Gulf of Mexico Basins: U. S. Geological Survey Water-Supply Paper 1682

____Compilation of Records of Surface Waters of the U. S.-October 1950 to September 1960; part 8 - Western Gulf of Mexico Basins: U. S. Geological Survey Water-Supply Paper 1732

____Surface Water Supply of the U. S. 1961-1965; part 8 - Western Gulf of Mexico Basins: U. S. Geological Survey Water-Supply Paper 1923

and State of New Mexico, 1966, 1967, 1968, 1969, 1970, Water Resources Data for New Mexico; part 1 - Surface Water Records

U. S. Weather Bureau, Climatological Data, 1900-1954, U. S. Government Printing Office

____Climatic Summary of U. S. - Supplement for New Mexico 1931-1960, U. S. Government Printing Office

____-Environmental Science Services Administration, Climatological Data, 1955-1959

U. S. Western Water Plan, November 1972, Streams and Stream Systems, A Working Document

CHAPTER IV

Economic Development

This chapter briefly describes the historical development of the basin. The socio-economics of the basin are viewed in the areas of education, population, economic activities, employment and unemployment, income, welfare, urban centers and their influence, and transportation. Agriculture, outdoor recreation, forest resources, range resources, water requirements, and the related economic activities of each are given separate consideration. The chapter concludes with a summary of land use requirements.

HISTORICAL DEVELOPMENT

The Rio Grande Valley is the oldest continuously settled region in the United States. Ruins of ancient villages and canals indicate that irrigation was practiced here more than 1,000 years ago. This valley was the center of a highly developed pueblo civilization for several centuries. About 20,000 to 30,000 Indians lived in 70 to 80 pueblo settlements along the main stream of the Rio Grande. They were cultivating and irrigating 15,000 to 25,000 acres of valley land when the Spanish explorers came in 1540. The pueblo people still live apart in small villages growing some crops for their own use. By metropolitan standards many are poor and do not have modern conveniences.

During the 16th and 17th centuries, the Spanish conquistadores explored and colonized much of the southwest including the Upper Rio Grande Basin. Spain and Mexico granted huge parcels of land to these colonizers. Their descendants still live in the region, many in rural areas with low income and few material goods. There is a strong tie which keeps them near their ancestral lands, although some have taken jobs in cities. The land has traditionally been divided among the children at the death of parents. After several generations, plots of land inhabited by these rural dwellers are too small to support a family. However, land ownership and occupancy has important value in the rural Spanish culture. Land is viewed in a traditional sense, contrasting the more common view that land is a commercial resource. Legal title to much of the land is unclear due to lack of transfer and sales records. Grant lands are sometimes held in common by a village for grazing and other common uses.

Settlers other than Spanish descendants and Indians began to inhabit the basin during the 18th century. Today they are concentrated mainly in the Albuquerque-Santa Fe area with some scattered throughout the basin.

SOCIOECONOMIC

The economic base is related in many ways to the basin's socioeconomic patterns. Small farm size and low farm sales are associated with low rural income, which brings on problems such as welfare and a sluggish rural population growth rate.

For purposes of this report, Bernalillo, Los Alamos, and Santa Fe Counties are referred to as urban or metropolitan while Rio Arriba, Sandoval, Socorro, Taos, Torrance, and Valencia Counties are referred to as rural. The urban counties generally have high income and education levels and low unemployment levels compared to the rural counties.

EDUCATION

Table IV-1 ranks the basin counties by median school years completed. Counties with low educational levels are generally those with high unemployment and low income.

TABLE IV-1. MEDIAN SCHOOL YEARS COMPLETED BY PERSONS 25 YEARS AND OLDER

	Median School Years Completed
Urban Counties	12.1
Rural Counties	8.9
Basin	11.4
State	11.2

Source: New Mexico Statistical Abstract, 1970, page 25.

POPULATION AND POPULATION CHARACTERISTICS

Nearly half of the 1970 New Mexico population resided in the basin. About 62 percent of the basin population lives in Bernalillo County.

During the period 1960-1970, Bernalillo, Los Alamos, Sandoval, and Santa Fe Counties gained about 20 percent each in population. Taos County gained 10 percent, Rio Arriba and Valencia Counties gained about 4 percent each, Socorro County lost 4 percent, and Torrance County lost 18 percent. The net gain in population was 16 percent basinwide. However, the basin lost 2,500 people between 1967 and 1970. State population gain during this same period was 6.7 percent. Basin population from 1940-1970 is shown in Table IV-2, page IV-3.

Most of the population gain since 1940 has been in Bernalillo County. For the period 1940-1970, Bernalillo County increased 355 percent in population while remaining areas of the basin increased 47 percent. This country-to-city trend is typical of the rest of the nation.

The age and ethnic distribution of basin residents does not differ significantly from state averages.

TABLE IV-2. HISTORICAL POPULATION - UPPER RIO GRANDE BASIN, NEW MEXICO - 1940-1970

County	1940	1950	1960	1967 1/	1970
Bernalillo	69,391	145,670	262,199	318,200	315,774
Los Alamos	0	10,480	13,037	17,700	15,198
Rio Arriba	25,352	25,000	24,193	23,000	25,170
Sandoval	13,898	12,440	14,201	18,500	17,492
Santa Fe	30,826	38,150	44,970	54,000	53,756
Socorro	11,422	9,670	10,168	11,300	9,763
Taos	18,528	17,150	15,934	17,000	17,516
Torrance	11,026	8,010	6,497	6,000	5,290
Valencia	20,245	22,480	39,085	36,800	40,539
TOTAL URG	200,688	289,050	430,284	502,500	500,498
TOTAL STATE	531,818	681,190	951,023	1,027,600	1,016,000

Sources: 1960 Census of Population
New Mexico Population since 1910, Bureau of Business Research, University of New Mexico, Arthur A. Blumenfeld
October 1970 "New Mexico Business", Bureau of Business Research, University of New Mexico

1/ Base year for input-output studies

POPULATION PROJECTIONS

Three sets of population projections for the basin are shown in Table IV-3. The OBERS projections were prepared by the Bureau of Economic Analysis, U. S. Department of Commerce, and the Economic Research Service, U. S. Department of Agriculture. They assume Series C birth rates and are based on projections of basin production relative to national production. Basin production was translated into employment and then population. The Bureau of

Business Research projections were prepared by Ralph Edgel at the New Mexico Bureau of Business Research. They share similar assumptions and procedures with the OBERS projections but are based on projection data prepared by Resources for the Future.

TABLE IV-3. POPULATION PROJECTIONS, UPPER RIO GRANDE BASIN

Year	1972 OBERS	1968 OBERS	BBR
1980	570,000	636,600	795,100
2000	710,500	942,300	1,408,900
2020	856,800	1,466,100	2,290,500

Sources: 1968 and 1972 OBERS projections prepared by Bureau of Economic Analysis, U. S. Department of Commerce, and Economic Research Service, U. S. Department of Agriculture, adapted to the basin by the Southwest Resource Group, Economic Research Service.

BBR projections prepared by Ralph Edgel at the New Mexico Bureau of Business Research.

The 1972 OBERS projections reflect 1970 Census of Population data, while the 1968 OBERS projections do not. The 1972 projections were not used extensively in this report, because they were not available until after the study was well under way. Subsequent reference to OBERS projections in this report refer to the 1968 OBERS projections.

ECONOMIC ACTIVITIES

Government, trade, and services are the most important sectors of the basin's economy. Of these, "government" is probably the biggest business.

Agriculture and tourist trade are more important in the rural areas. Agriculture in the form of small farms and cattle ranches, mining, and outdoor recreation comprise the resource-oriented sectors of the economy and account for the bulk of land and water use.

The importance of sectors of the economy can be represented to some degree by employment, total gross output, and value added. Tables IV-4, IV-5, and IV-6 rank the sectors of the basin economy by these measures. The ranking is strongly influenced by patterns in Albuquerque and does not show predominant economic patterns in the rural counties.

TABLE IV-4. EMPLOYMENT - UPPER RIO GRANDE BASIN, NEW MEXICO

Rank	Sector	Numbers Employed (1968)
1	Government	49,620
2	Trade	36,230
3	Services	36,220
4	Manufacturing	11,140
5	Transportation, Communication, & Utilities .	10,840
6	Construction	10,020
7	Finance, Insurance, & Real Estate	8,020
8	Agriculture	2,950
9	Mining	2,090

Source: New Mexico Employment Security Commission, Albuquerque, NM

TABLE IV-5. OUTPUT 1/ - UPPER RIO GRANDE BASIN, NEW MEXICO

Rank	Sector	Estimated 1967 ($1,000)
1	Government	Unknown, but substantial
2	Services	538,432
3	Trade	380,842
4	Transportation, Communication, & Utilities	273,371
5	Manufacturing	221,723
6	Finance, Insurance, and Real Estate	169,173
7	Construction	135,321
8	Mining	69,736
9	Agriculture	46,689

Source: Estimates for Basin Input-Output Model

1/ Output is the total value of goods and services sold by sectors of basin economy.

TABLE IV-6. VALUE ADDED 1/ - UPPER RIO GRANDE BASIN, NEW MEXICO

Rank	Sector	Estimated 1967 ($1,000)
1	Government	Unknown, but substantial
2	Services	301,390
3	Trade	251,950
4	Transportation, Communication, & Utilities	183,623
5	Finance, Insurance, & Real Estate	125,405
6	Manufacturing	89,120
7	Construction	56,233
8	Mining	48,381
9	Agriculture	19,151

Source: Basin Input-Output Model

1/ Value added is a measure of increase in value of a product as it proceeds through stages of production.

EMPLOYMENT

Bernalillo, Los Alamos, and Santa Fe County employment patterns overshadow patterns in the rural counties. Government, services, and trade employ over half the total. Manufacturing follows, while basic industries such as agriculture and mining account for less than 5 percent of the total.

EMPLOYMENT PROJECTIONS

Two sets of Upper Rio Grande employment projections were made so that a range of underlying assumptions could be considered. The first set is OBERS-based and is underlain by the same assumptions as are the OBERS population projections. Work force as a percent of population, and employment as a percent of work force are estimated for each economic region as it contributes its share to national production. Economic area 10139 (Albuquerque) projections cover most of the basin and constitute a major factor in the employment projections.

The second set of employment projections is based on those made by the New Mexico Bureau of Business Research. They yield the higher of the two sets and were made by summing BBR employment projections for counties falling within the Upper Rio Grande Basin boundaries. The assumptions behind them are that employment in New Mexico's basic industries will depend upon out-of-state demands for New Mexico resources as the national economy grows. Employment in New Mexico's secondary industries was assumed to depend upon the size of local markets. The BBR employment projections assume a 5 percent unemployment rate.

Table IV-7 shows these projections. Both sets show healthy employment increases, but the BBR projections increase more rapidly than OBERS.

TABLE IV-7. EMPLOYMENT PROJECTIONS BY INDUSTRY, UPPER RIO GRANDE BASIN, NEW MEXICO

	Employment Numbers (Thousands)					
	1980		2000		2020	
	OBERS 1/	BBR 2/	OBERS	BBR	OBERS	BBR
Agriculture	2.6	3.6	1.8	2.9	1.1	4.5
Mining	2.1	5.7	2.3	12.2	2.6	17.4
Manufacturing	20.9	22.4	30.1	40.0	44.1	90.9
Construction	17.6	19.7	24.8	32.9		
T. C. U.	12.9	17.3	15.0	30.3		
Trade	43.6	52.8	63.0	94.7		
F. I. R. E.	10.6	14.1	17.0	29.9		
Services	93.0	68.2	159.0	136.6		
Public Admin.	23.5	65.2	39.0	117.4		
Armed Services	6.7	9.6	6.8	11.8		
Other					517.0	705.4 3/
TOTAL	233.5	278.6	358.8	508.7	564.8	818.2

1/ Source: Adapted to URG Basin from 1968 OBERS projections.
2/ Source: Edgel, Ralph L., Undated.
3/ Subtotal for Construction, T.C.U., Trade, F.I.R.E., Services, Public Admin., and Armed Services.

Agricultural employment finds a steady decline according to OBERS, but BBR sees it declining to year 2000 and then making a sharp increase. Both sets show mining employment rising after year 1980. All other employment categories are expected to increase, although some may decrease in their relative positions. Manufacturing is expected to show a steady increase according to BBR, but OBERS sees it as only holding its own. Some fields such as construction, transportation, communications, utilities, trade, and armed services may decrease relative to other fields. Services are expected to find considerable relative employment increases as are public administration, finance, insurance, and real estate.

UNEMPLOYMENT

Unemployment in the rural counties of the basin is a major problem as shown in Table IV-8. Rates are twice those found in the metropolitan counties. Unemployment is associated with low education levels. Rio Arriba County with a 15.5 percent unemployment rate had an 8th grade median education level in 1960. Taos County is similar with a 10 percent unemployment rate and about an 8th grade median education level. On the other hand, the metropolitan counties have low unemployment levels and high education levels. Unemployment in the rural counties is also related to the seasonal labor demands of agriculture, forestry, and recreation, and the general lack of economic opportunity. The 1968 unemployment rate for the basin as a whole is almost the same as the state rate. These rates continued through 1970 with only minor changes. Early in 1971 there was a slight increase in the state unemployment rate.

Unemployment insurance payments per unemployed worker in the basin during 1968 were $523 compared to $456 for the state. Rio Arriba County payments were $727 per unemployed worker. (New Mexico Statistical Abstract, 1970).

TABLE IV-8. ANNUAL AVERAGE UNEMPLOYMENT 1968 - UPPER RIO GRANDE BASIN, NEW MEXICO

County	Persons Unemployed	Percent of Work Force Unemployed
Rural Counties	2,423	8.9
Metropolitan Counties	6,011	4.2
Basin	8,434	5.0
State	18,300	4.9

Source: New Mexico Statistical Abstract, 1970, pages 33-35.

INCOME

Average personal per capita income in the basin is slightly above that of the state (Table IV-9). However, in the rural counties of the basin it is $1,635 or one-third below the state average. By contrast, in Bernalillo, Los Alamos, and Santa Fe Counties, per capita personal income is $2,746 or about 13 percent above the state average.

Low average incomes in the rural counties are due to the small farms and lack of industry. On the other hand, the metropolitan counties have a more active economy based on trade, service, government, and industry. During 1959, 36 percent of the basin families had income below $3,000 compared to 24 percent for the state. (New Mexico Statistical Abstract, 1970).

Basin per capita income is below the national average but predicted to approach it in the future. According to OBERS data, Albuquerque had a 1940 per capita income of $728, or 56 percent of the national average. The position has improved, however, as shown in Table IV-10, page IV-9. Per worker earnings in the basin more nearly approach the national average than does personal income.

Income levels in the basin are predicted to increase and approach the projected national level. Per capita income in 1967 was $2,497 (New Mexico Statistical Abstract 1970, Vol. 1). This is predicted to increase to $3,553 in 1980 and to $11,740 by 2020. By 2020 per worker earnings in the basin are predicted to be nearly equal to national per worker earnings at $23,277 per year.

TABLE IV-9. AVERAGE PER CAPITA INCOME, 1967 - UPPER RIO GRANDE BASIN, NEW MEXICO

County	Income $
Average Rural	1,635
Average Metropolitan	2,746
Basin Average	2,497
State Average	2,419

Source: New Mexico Statistical Abstract, 1970.

TABLE IV-10. INCOME AND EARNINGS - HISTORICAL AND PROJECTED - UPPER RIO GRANDE BASIN, 1940-2020

	1940	1950	1959	1970	1980	2000	2020
Income:							
Per capita (EA 10139) 1/	728	1293	1855	2544	3553	6593	11,740
Relative to U.S.(U.S.=1.00)	.56	.72	.87	.84	.86	.96	.95
Per capita U.S.	1296	1805	2134	3046	4112	7161	12,411
Earnings:							
Per worker (EA 10139) 1/	2559	3530	4852	6133	7867	13537	23,277
Relative to U.S.(U.S.=1.00)	.83	.90	1.04	.97	.97	.99	1.00
Per workers U.S.	3070	3935	4685	6310	8080	13617	23,362

1/ OBE Economic Area 10139 - Albuquerque and its trading area.
Source: 1968 OBERS Projections.

Federal lands return considerable income to counties of the basin. Collections by the Forest Service and the Bureau of Land Management are turned over to the Federal Treasury. In most cases 25 percent of the collection is returned to the counties from which it originated or to school districts.

For Fiscal Year 1970 the Federal Treasury returned over $5 million to the basin counties and schools as a result of BLM operations. As a result of Forest Service activities in the basin during Fiscal Year 1969, $295,000 was returned (data from Cibola, Carson, and Santa Fe Forests). These figures do not include money spent by federal agencies to purchase local materials and labor.

WELFARE

Financial assistance in the basin through the Welfare Program and other assistance programs during Fiscal Year 1967 totaled over $20 million, half the total state payments. Included in this figure are old-age assistance, aid to families with dependent children, needy, blind, disabled, general assistance, and medical assistance.

This averages out to $40 per capita in the basin and $38 per capita statewide. Again there is a wide gap between the basin's rural and metropolitan counties (Table IV-11, page IV-11). The metropolitan counties had average per capita welfare payments of $36. The overall rural county per capita payment average was nearly $54 per resident, considerably higher than the state average. Two rural counties, Valencia and Sandoval, had per capita payments lower than the metropolitan average.

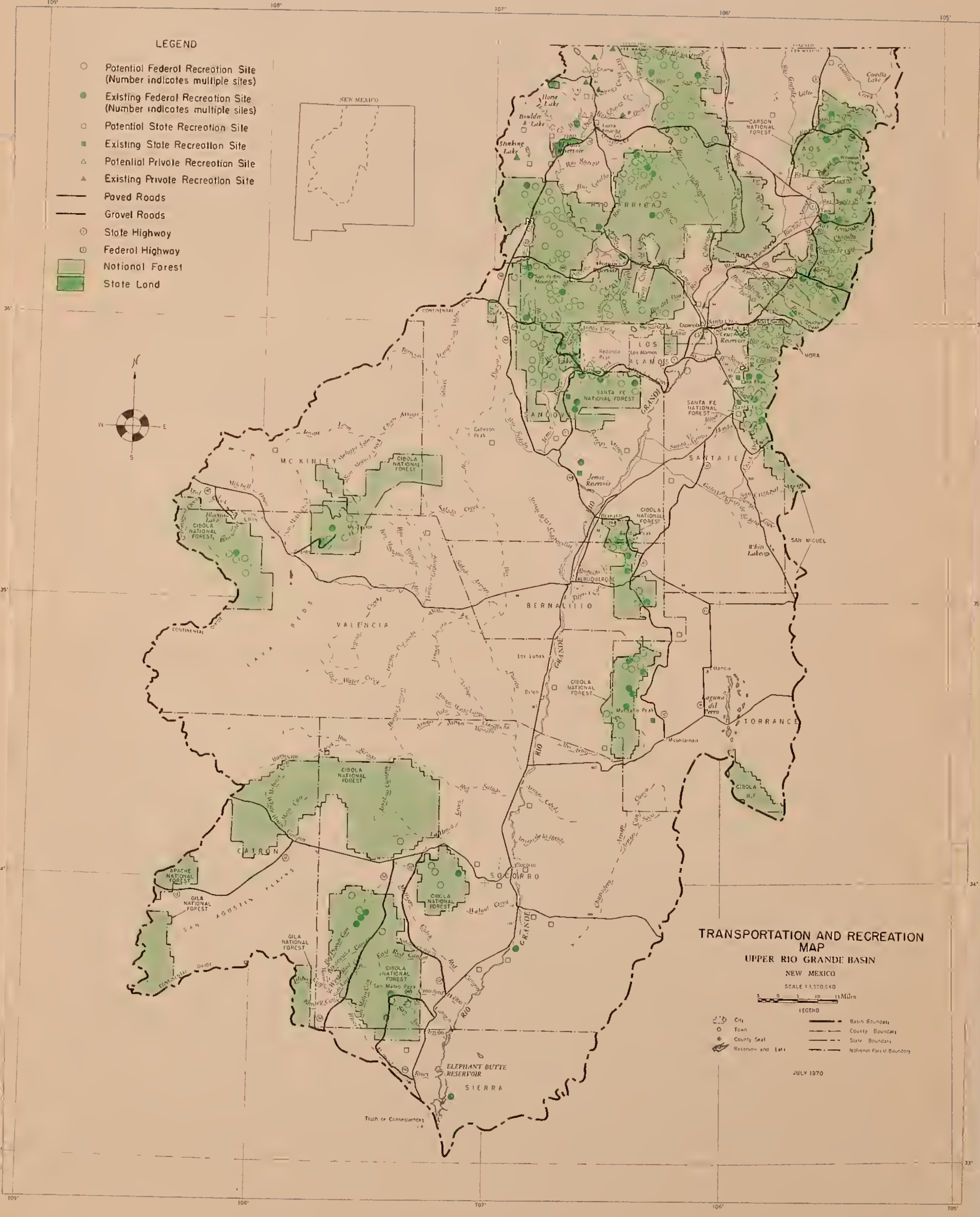

LEGEND
Potential Federal Recreation Site (Number indicates multiple sites)
Existing Federal Recreation Site (Number indicates multiple sites)
Potential State Recreation Site
Existing State Recreation Site
Potential Private Recreation Site
Existing Private Recreation Site
Paved Roads
Gravel Roads
State Highway
Federal Highway
National Forest
State Land
NEW MEXICO
TRANSPORTATION AND RECREATION MAP
UPPER RIO GRANDE BASIN
NEW MEXICO
JULY 1970
CARSON NATIONAL FOREST
SANTA FE NATIONAL FOREST
CIBOLA NATIONAL FOREST
GILA NATIONAL FOREST
APACHE NATIONAL FOREST
MC KINLEY
VALENCIA
BERNALILLO
TORRANCE
CATRON
SOCORRO
SIERRA
SANTA FE
SAN MIGUEL
LOS ALAMOS
MORA
ALBUQUERQUE
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
RIO GRANDE

TABLE IV-11. FINANCIAL ASSISTANCE AND MEDICAL PAYMENTS - UPPER RIO GRANDE BASIN, NEW MEXICO, FISCAL YEAR 1967

County	Total 1/ Payments ($)	Per Capita Average ($)
Metropolitan Counties	14,254,300	36.56
Rural Counties	6,039,400	53.63
Basin	20,293,700	40.38
State	39,534,000	38.47

1/ Source: New Mexico Statistical Abstract, 1970

URBAN CENTERS AND THEIR INFLUENCE

Albuquerque, with a 1970 population of nearly a quarter of a million people, is the largest urban area in the basin and state, and serves as the dominant trading center of the state. El Paso, Texas is the major trading center for the southern portion of the basin. Santa Fe is a local trading center serving the northern basin area. Gallup also serves as a local trading center. Other trading centers are shown in Figure IV-1.

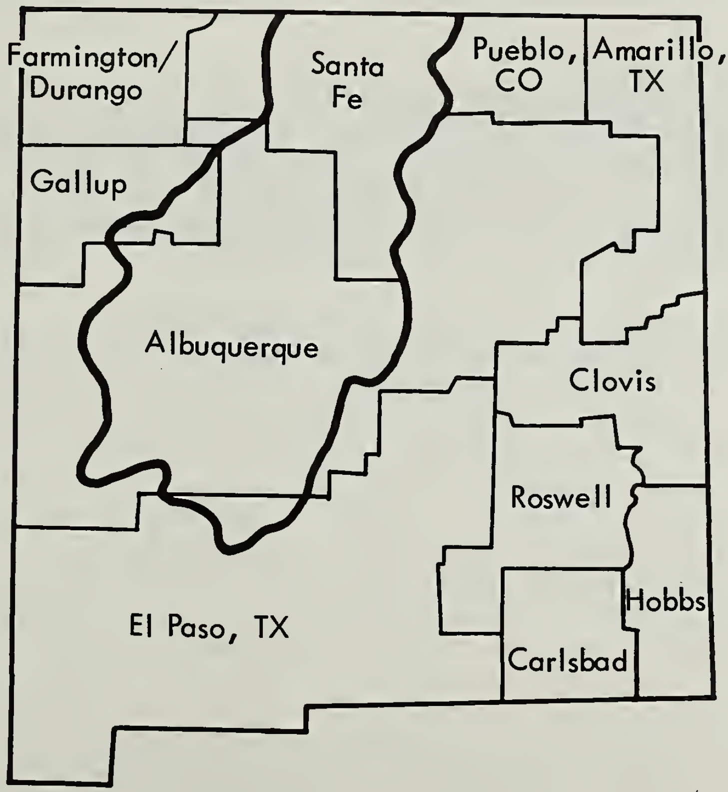


FIGURE IV-1. NEW MEXICO BASIC TRADING CENTERS. SOURCE: RAND McNALLEY MARKETING ATLAS, 100TH EDITION.

The effect or influence of urban centers is indicated in the previous sections. Education, employment, and income are higher in the urban areas than the rural areas. Unemployment and assistance payments are in most cases lower in the metropolitan areas than the rural areas.

TRANSPORTATION

Interstate 40 (U.S.-66) crosses the basin east and west passing through Grants and Albuquerque. Interstate 25 runs north and south through the basin to Glorieta, southeast of Santa Fe. Some small towns and villages do not have all-weather roads adequate to provide dependable school bus service. Adequate truck routes and loading facilities may be lacking.

Amtrak rail passenger service is available in Albuquerque. Freight service by rail is available throughout much of the basin. Major airlines serve Albuquerque, where international service began in late 1971.

AGRICULTURE AND RELATED ECONOMIC ACTIVITY

The total value of agricultural products sold from basin farms was nearly $44 million in 1969. Sales of livestock and livestock products accounted for 85 percent of the total while crop sales accounted for 15 percent. Agricultural production employed about 3,000 persons in 1968 and was associated with about 400 additional nonagricultural jobs in the basin.

Consolidation of farms into viable economic units is taking place. Since 1949 the number of farms has decreased by 68 percent, the average value of land and buildings per farm has increased more than ten-fold, the average acreage per farm has more than doubled, and the average value of farm products sold per farm has increased more than seven-fold. However, in 1969, 52 percent of basin farms still had annual sales of less than $2,500. These farms sold less than 9 percent of the basin's farm output. More than 80 percent of the basin farms had sales of less than $10,000. On cow-calf ranches, the predominant type of farm organization, sales of $10,000 produce net farm income of between $4,500 and $5,800 on the average. 1/

1/ Estimated from data contained in J.R. Gray "Cattle and Sheep Ranching in New Mexico", New Mexico Agriculture - 1972. Net farm income is the return over current expenses. It represents the return to the operator and ranch capital.

TABLE IV-12. FARM CHARACTERISTICS, UPPER RIO GRANDE BASIN, NEW MEXICO (1949-1969)

	1949	1954	1959	1964	1969
Number of farms	7,936	7,450	4,841	4,186	2,551
Commercial 1/	2,822	2,478	1,945	1,826	1,225
Part-time	1,163	1,251	2,142	1,616	839
Part-retirement	-----	-----	729	712	204
Irrigated	5,493	5,368	3,401	3,301	1,437
Type of farms 2/					
Field crop	696	273	117	59	24
Vegetable	97	97	42	39	27
Fruit and nut	137	278	103	107	24
Dairy	169	182	82	28	46
Poultry	59	65	91	81	13
Livestock (other than dairy and poultry)	1,309	1,317	1,230	974	827
General	313	274	243	355	199
Miscellaneous	5,156	4,968	2,938	2,543	65
Average farm size (acres)					
All farms	1,314	1,479	2,029	2,425	3,780
Commercial	-----	-----	3,813	4,121	5,520
Land in farms (acres, 000's)	10,429	11,128	10,626	10,153	9,654

Source: U.S. Census of Agriculture

1/ Commercial farms are defined as having more than $2,500 in sales.

2/ In 1969, only commercial farms were classified by type.

PHOTO IV-1. CORN PRODUCED AND PROCESSED LOCALLY

SCS PHOTO 12-P374-5

PHOTO IV-2. MUCH OF THE IRRIGATED AREA IS IN IRRIGATED PASTURE OR HAY

SCS PHOTO

TABLE IV-13. FARM VALUE AND SALES, UPPER RIO GRANDE BASIN, NEW MEXICO (1949-1969) - DOLLARS

	1949	1954	1959	1964	1969
Value of land & buildings					
Average per farm					
All farms	14,067	20,877	30,304	79,027	154,840
Commercial farms	------	------	53,088	116,734	197,226
Average per acre					
All farms	15.48	18.70	37.64	32.64	44
Commercial farms	-----	-----	27.45	27.54	36
Value of farm products sold					
Average per farm					
Commercial farms	-----	-----	-----	9,205	32,816
All farms	2,225	2,345	4,556	4,671	17,167
Percent crops	31	34	19	28	15
Percent livestock	69	66	81	72	85

Source: U.S. Census of Agriculture

PHOTO IV-3. SCENIC BEAUTY - HONDO CANYON, VALDEZ VALLEY

SCS PHOTO 12-P372-16

PHOTO IV-4. TYPICAL CROPPING AND OWNERSHIP PATTERN IN NORTHERN NEW MEXICO. FRIJOLES CREEK ABOVE SANTA CRUZ RESERVOIR

SCS PHOTO 12-P918-5

TABLE IV-14. PERCENT OF FARMS BY VALUE OF FARM PRODUCTS SOLD (1969)

Sales Class (Dollars)	Percent of Farms in Sales Class: Basin	State
Less than 250	11.3	7.3
250 - 499	7.8	4.6
500 - 999	12.9	8.2
1,000 - 1,499	7.8	5.8
1,500 - 1,999	7.4	5.2
2,000 - 2,499	5.3	3.8
2,500 - 4,999	16.1	15.1
5,000 - 9,999	12.3	14.0
10,000 - 19,999	8.1	13.5
20,000 - 39,999	5.1	10.7
40,000 and over	5.9	11.8

Source: U.S. Census of Agriculture, 1969

TABLE IV-15. CROPS HARVESTED, IRRIGATED PASTURE, AND LAND IRRIGATED, COMMERCIAL FARMS (1969)

Crop	Irrigated	Non-Irrigated	Total
	acres		
Corn	10,697	1,213	11,910
Sorghum	2,498	160	2,658
Small grain	3,974	3,798	7,772
Cotton	1,561	- -	1,561
Hay	38,011	3,920	41,931
Other harvested crops	5,550	533	6,083
Total crops harvested	62,291	9,624	71,915

Irrigated pasture, acres 18,187
Total land irrigated, acres 81,610

Source: 1969 Census of Agriculture

AGRICULTURAL PROJECTIONS

Because irrigated agriculture is the major water user in the basin, two projections of irrigated acreage were made. The OBERS projections were developed by projecting total production, crop yields, and the relationship between harvested acreage and irrigated acreage. OBERS production projections were then translated into projections of irrigated acreage. The state projections were developed by the New Mexico State Engineer's Office. Projected irrigated acreage was based on estimates of water supplies to be available for agriculture assuming water rights are not transferred to other uses.

A comparison of the OBERS and state projections is shown in Table IV-16. The OBERS projections show an increase in land irrigated of 19 percent between 1969 and 2020. Irrigated cropland is projected to increase from about 87 percent of cropland harvested in 1969 to 97 percent in 2020. The state projections show an increase in land irrigated of 32 percent between 1969 and 2020.

TABLE IV-16. COMPARISON OF OBERS 1/ AND STATE 2/ IRRIGATED ACREAGE PROJECTIONS, UPPER RIO GRANDE BASIN

Year	State Projections			OBERS Projections
	Land developed for irrigation	Land idle, fallow, etc.	Land Irrigated	Land Irrigated
	acres			
1969	220,600	53,000	167,600 3/	111,000 3/
1980	241,300	39,500	201,800	111,000
2000	256,800	35,700	221,100	120,000
2020	257,600	35,800	221,800	132,000

1/ Estimates prepared by Southwest Resource Group, Economic Research Service, USDA, based on the 1968 OBERS projections and Census of Agriculture data.

2/ Estimates prepared by the New Mexico State Engineer's Office.

3/ Acreages for 1969 as reported by the New Mexico State Engineer's Office and the 1969 Census of Agriculture. The difference between the two base year estimates is due to sampling and non-sampling errors in the 1969 Census of Agriculture and inclusion of part of Sierra County in the state estimate. Sampling error of 12.7 percent in the Census of Agriculture estimate is consistent with the 99 percent level of confidence. Non-sampling errors due to non-response, incorrect reporting, processing errors, etc., are not estimated but are usually larger than sampling errors.

OUTDOOR RECREATION AND RELATED ECONOMIC ACTIVITY

A variety of landscapes and a wide range of climate, plus the tri-cultural heritage of the basin, provide varied and plentiful recreational possibilities (see Transportation and Recreation Map, facing page IV-10). Mountains in the north offer hunting, fishing, camping, and skiing. Pueblos, early Spanish settlements, and other historical sites offer the tourist a variety of other attractions. Elephant Butte and several smaller reservoirs offer water-based recreation. Much land in the basin is public domain open to those who wish to explore it. A recent revived attraction is the Cumbres and Toltec Narrow Gauge Steam Railroad, which carries sightseers between Chama, New Mexico and Antonito, Colorado. Forty-eight miles of the Rio Grande gorge from the Colorado state line south, including the lower four miles of Red River, is a designated wild river, another natural attribute to this area. In a matter of an hour or so one can observe the beauty of high, mountainous areas and the changing colors of the semi-desert areas.

Over a half million acres of private and public land are developed for outdoor recreation use. Approximately five million acres are available if all national forest, BLM recreation lands, other federal, state, and local areas, and private recreation lands are included.

It has been estimated that in 1960 there were over 17 million visitor or recreation days experienced in the basin. Active sports (camping, hunting, walking, mountain climbing, etc.) account for most of the total. Passive activities (picnics, driving, sight-seeing, etc.) accounted for a lesser amount. Water-based sports rank third and winter sports last. These activities created a requirement for an estimated 389,500 acres of land and water (recreation days x Forest Service space standards) in 1960.

Table IV-17 indicates that space needs probably were adequate in 1968. The 547,700 acres include land specifically set aside for outdoor recreation use by various local, state, and federal agencies plus private recreation land estimates.

Much of the requirement for recreation is met on multiple use lands. At present, it is estimated that ski areas, cabin areas, trails, and water surface for boating are adequate; however, there is a shortage of areas for picnicking and camping.

"Outdoor Recreation - New Mexico", the New Mexico Comprehensive Plan for Outdoor Recreation, indicates that at the present time specific outdoor recreation facilities are lacking in areas near cities.

PHOTO IV-5. RECREATION - SKIING IS A POPULAR WINTER SPORT IN NEW MEXICO

SCS PHOTO 12-P592-14

PHOTO IV-6. HORSEBACK RIDING IS A POPULAR TYPE OF RECREATION

SCS PHOTO 12-ORC-39-13

TABLE IV-17. APPROXIMATE INVENTORY OF OUTDOOR RECREATION FACILITIES AND AREAS, 1968 - UPPER RIO GRANDE BASIN, NEW MEXICO

	Number	Acres	Miles
Picnic areas	29+	1,734+	
Campgrounds	26+	1,376+	
Cabins and homesites 1/ . .	10,452	33,290	
Guest ranches	12	35,387	
Group camps	22	5,018	
Lodges	49		
Golf courses	15		
Swimming pools	21		
Boat access	3		
Marinas	2		
Ski areas	7		
Fishing streams			1,000
Fishing & boating lakes 1/		Up to 40,000	
Hunting areas		441,000	
Trails 1/			1,656
TOTAL (rounded)		547,700	

1/ Cabins and homesites listed here are all on private land. Almost all of the 40,000 acres of lakes is that of Elephant Butte, which fluctuates in size due to irrigation allocations. Half the hunting area listed is on Indian lands and most of the trails are in the national forests.

Source: New Mexico State Outdoor Recreation Plan and Map, New Mexico Fishing Waters, New Mexico Department of Game and Fish.

PHOTO IV-7. WINTER SPORTS FACILITIES - SANTA FE SKI LODGE AND CHAIRLIFT
US FOREST SERVICE PHOTO

It was estimated by McArthur, Summitt, and Coopedge (unpublished manuscript) that 1,191,000 people visited the northern part of the basin during 1967. Federal and state recreation areas entertained an estimated four million visitor days during 1967. Most of these were in state parks and national forests.

Outdoor recreational visits create considerable income. Visitors to the northern part of the basin have been estimated to have expenditures of $9.05 per visitor day (unpublished manuscript). Average expenditures per day of activity at Elephant Butte Reservoir (1966) were estimated to be $9.09 (NMSU Agricultural Experiment Station Bulletin 535, 1968). Expenditures of skiers visiting New Mexico ski areas during the ski season was about $21.12 (Intermountain Forest and Range Experiment Station Research Paper INT-34, 1967).

For 1967 it was estimated that outdoor recreation activities were responsible for about $148 million of expenditures, $73 million of which represent margin or markup value (estimated by ERS via basin input-output model). These expenditures are estimated to be 10 percent of the state total and generated over $92 million worth of output through the basin's economy. Resulting wages are estimated at $49 million (five percent of non-government basin total) and employment is estimated at over 15,000 jobs (11 percent of the basin total). Most of these impacts occur in the trade and service sectors, which serve outdoor recreation activities.

Increasing leisure time, income, and mobility are expected to increase outdoor recreation activities of all people. The basin will feel this increase in the form of more visitors. The basin can provide for this amount of participation from a physical standpoint, however, legislative and economic provisions will have to be made to harvest recreation benefits and at the same time not harm the environment.

Outdoor recreation visitor days in 1980, 2000, and 2020 are projected by applying indices of projected activity to the basic 1960 estimates. Projected and 1960 recreation or visitor days are shown in Table IV-18, page IV-24.

TABLE IV-18. 1960 AND PROJECTED VISITOR DAYS - UPPER RIO GRANDE BASIN, NEW MEXICO

Activity	1960	1980	2000	2020
Water-Based 1/	2,538,600	4,597,800	7,856,900	10,846,300
Active 2/	8,425,800	15,677,600	22,619,300	32,199,600
Passive 3/	6,651,600	11,922,200	17,418,800	22,821,800
Winter 4/	168,800	379,700	588,800	797,900
TOTAL (rounded)	17,784,800	32,577,200	48,483,800	66,665,800

1/ Water-based includes fishing, boating, swimming, and water skiing.
2/ Active includes camping, hunting, bicycling, horseback riding, outdoor sports and games, walking, hiking, mountain climbing, and nature walks.
3/ Passive includes picnics, driving, sightseeing, and attending outdoor sports, events, and concerts.
4/ Winter sports include ice skating, snow skiing, sledding, snow mobiling, and tobogganning.

Source: Estimated by ERS based on ORRRC reports participation data and basin and national OBERS population projections.

At the present time there are about 550,000 acres of designated recreation area. Recreation area development needs for the future are:

1980 - 174,000 acres
2000 - 496,000 acres
2020 - 939,000 acres

These figures represent an average estimate. At given times of the year or for given activities there may be surplus land or crowded areas. The basin has the physical assets to meet this level of outdoor recreation activity, but some of the area would have to be developed more intensively to accommodate the increased level of activity.

Multiplying figures in Table IV-18 by a factor to convert them to acres gives estimates of outdoor recreation area requirements as follows:

1960 - 389,500 acres
1980 - 724,700 acres
2000 - 1,046,300 acres
2020 - 1,489,100 acres

PHOTO IV-8. WATER ORIENTED RECREATION ON THE LARGER RESERVOIRS. VISITORS FROM FAR AWAY AREAS GO BOATING, FISHING, AND WATER SKIING ON LAKES IN THIS AREA.

US FOREST SERVICE PHOTO

FOREST RESOURCES AND RELATED ACTIVITY

UTILIZATION, VOLUME, AND VALUE OF OUTPUT

The goal in timber resource management is to establish a sustained yield base for the timber resource for future uses. To meet the goal, commercial timber species are harvested according to their silvicultural requirements and meet the management objectives. Figure IV-2, page IV-28, is OBERS projection of the anticipated demands for wood products from the Rio Grande Water Resource Region. At the present time industry is largely oriented toward sawlog production. Other products include posts, corral and utility poles, house logs, and mining timber. Pulp material is estimated at 8.4 million cords. Chips are now being shipped from Bernalillo to a pulp mill in Arizona. Noncommercial species, primarily pinyon and juniper, are used for firewood, fence posts, and ornamentals. Pinyon nuts provide food, recreation, and some income for local people.

The estimated annual allowable cut for the basin is 160 million board feet. The harvest in fiscal year 1969 was about 125 million board feet, which was valued at about $1,250,000. This annual volume cut represented about 45 percent of the state's production. It is estimated that 15 percent of the volume harvested is utilized within the basin. Nearly two-thirds of the state's exports were shipped to adjacent states (New Mexico Agricultural Experiment Station, 1965).

Nearly 67 percent of the commercial forest land is managed by the Forest Service. The allowable cut on the National Forest is 103.4 million board feet. The National Forest objectives are to protect, develop, and utilize the resources to contribute maximum social and economic benefits on a sustained yield basis in harmony with other resources and activities. In fiscal year 1970, 75.8 million board feet were harvested, returning nearly $650,000 to the U.S. Treasury. Twenty-five percent of the timber sale receipts, about $162,000, were distributed by the U.S. Treasury to the counties in which the sales occurred. The price of timber (stumpage) is based on numerous variables, including tree species, quality, current market prices, and road construction. Stumpage prices varied from $5 to $20 per thousand board feet.

EMPLOYMENT AND INCOME

Forest resource related activities include managing the forest, timber harvesting, primary and secondary manufacturing, building, transportation, and marketing. Employment fluctuates with the demand for products and the season.

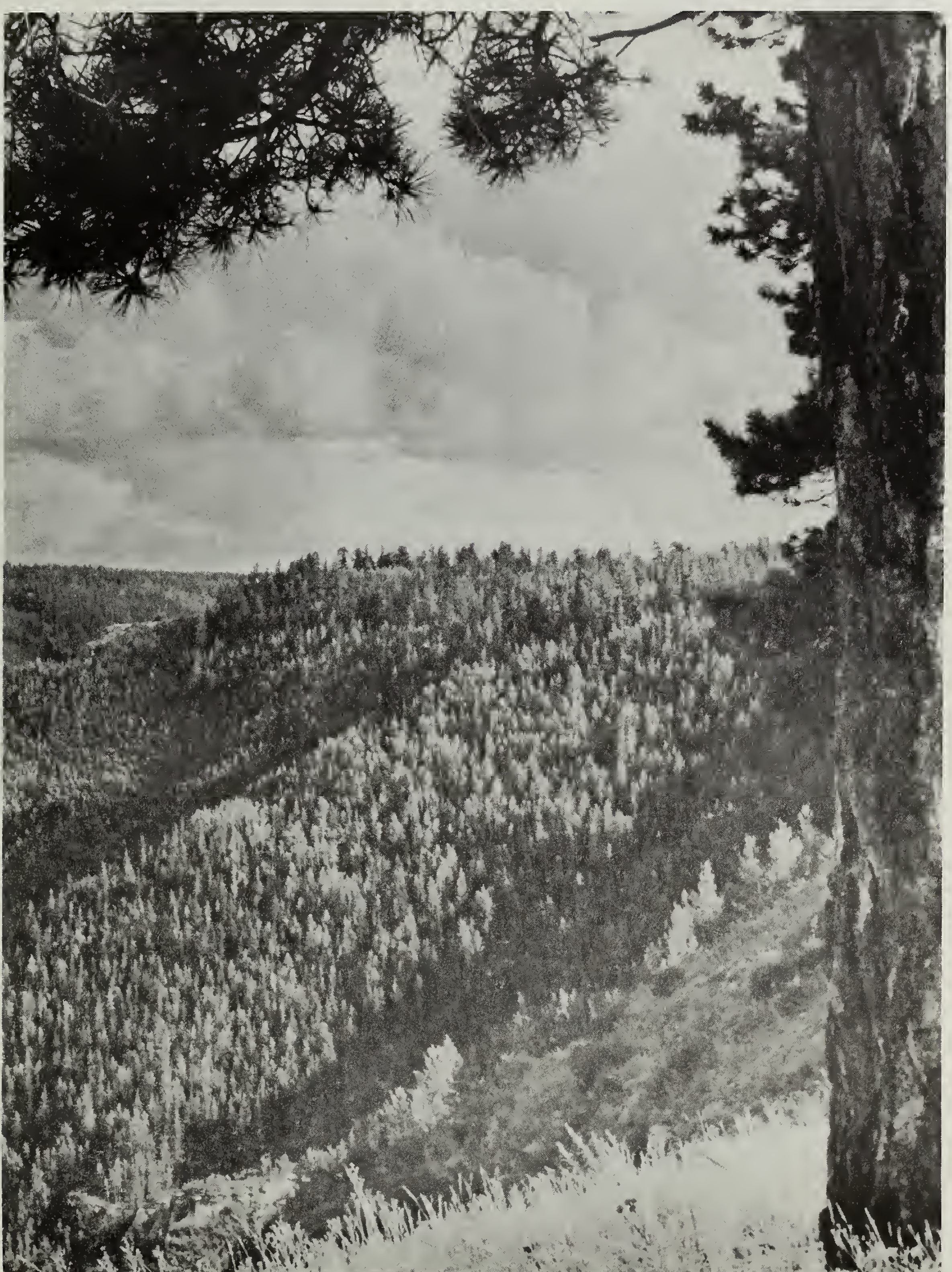


PHOTO IV-9. TYPICAL FOREST RESOURCES IN THE UPPER RIO GRANDE BASIN, NEW MEXICO US FOREST SERVICE PHOTO

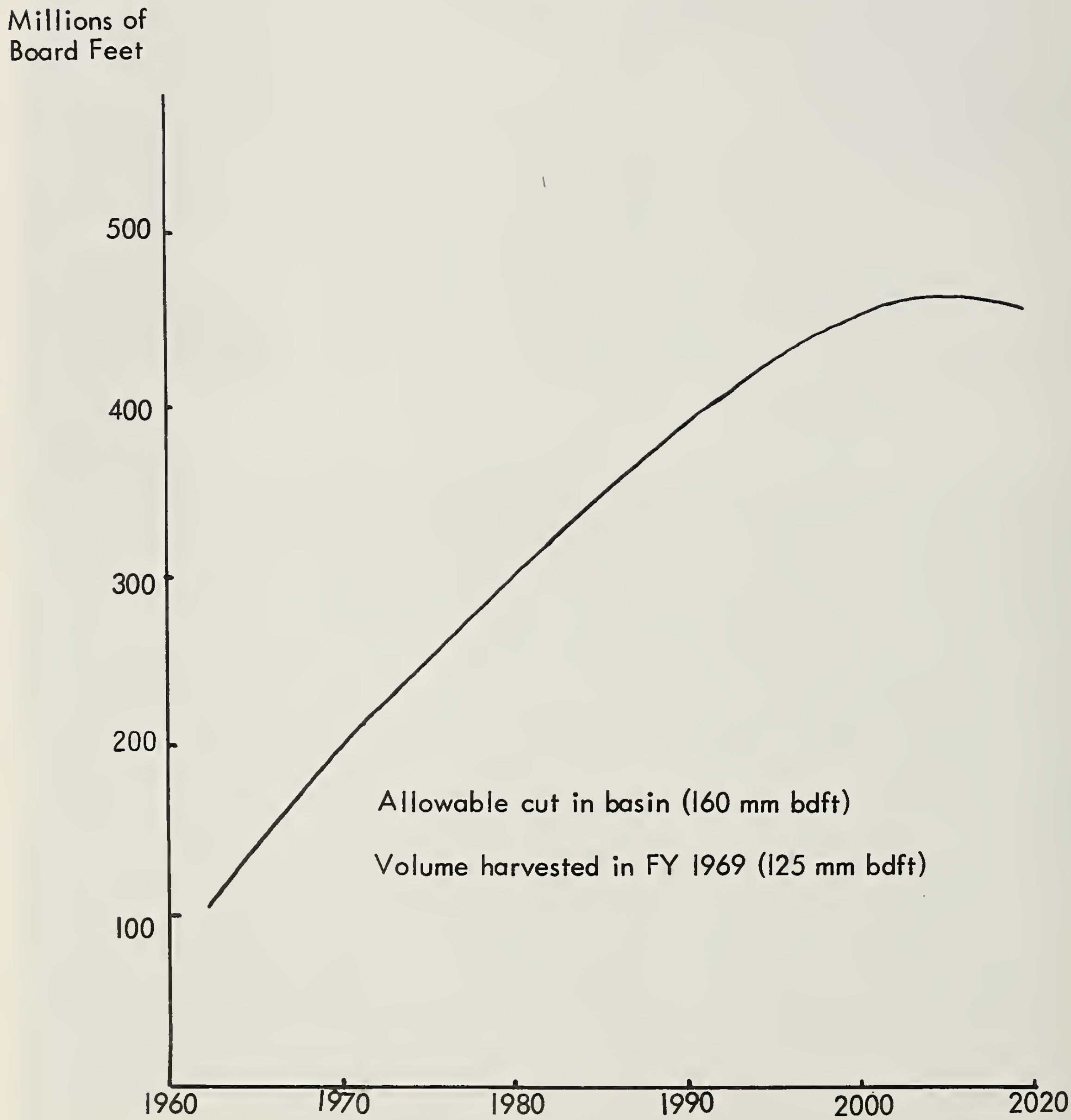


FIGURE IV-2. PRODUCTION OF SAWLOGS, VENEER LOGS, AND MISCELLANEOUS INDUSTRIAL TIMBER PRODUCTS, 1962 WITH PRELIMINARY PROJECTIONS TO 1980, 2000, and 2020, WATER RESOURCE REGIONS

About 16 active sawmills are operating within the basin. Four other mills outside the basin are dependent upon the basin for timber. These operations employ about 700 people. A study conducted by the Forest Service and Bureau of Business Research (Pulp and Papermaking Opportunities in Northern New Mexico, undated) shows average weekly earnings of $59.91 per employee in the lumber industry in four northern New Mexico counties. This is below the average for the state, which is $80.48. Salaries alone contribute about $2 million annually to the basin economy. Lumber and primary processing mills have about $15 million invested in buildings and equipment. Projections to 1980 of employment in the timber industry and the value of the harvest for the state are expected to more than double.

RANGE RESOURCES AND RELATED ACTIVITY

Portions of the open range lands have been in use since 1600 when the Spanish settlers established settlements in the Rio Grande valley. Indications are that the intensity of use peaked out during the period 1918-1922. It is estimated that 94 percent (17.8 million acres) of the basin is used for grazing. The majority of these lands is semi-arid in character. The erratic precipitation has a great influence on the annual availability of forage and water.

Rangeland for domestic livestock grazing is also used by big game animals. Competition between big game and livestock has been for winter range. Some of the larger private landholders charge a fee for hunting and fishing privileges.

Livestock farms are the most popular type of enterprise. In 1969, 85 percent of the farm sales were in the form of livestock and livestock products. The national downward trend of sheep numbers are reflected in the basin. According to the New Mexico Agricultural Statistics, sheep numbers in the basin declined from 326,000 to 253,000 while cattle numbers increased from 274,000 to 327,000 during the period 1960-1970.

There are 8.4 million acres of public lands that allow grazing by paid permits. A large percent of the livestock operations are small, having less than 200 head. These small operations are usually supplemented with other forms of local employment.

WATER REQUIREMENTS

Three levels of future water requirements have been estimated based on projected population and economic activity. Future water requirements were estimated using the 1967 water use coefficients as a base and projections of sectoral output from the basin input-output model. The OBERS level is the lowest of the three. Irrigation is expected to continue as the largest water user in the basin according to the OBERS projections; however, it is expected to comprise a decreasing portion of total depletion. It is expected that crop irrigation will comprise three-fourths of the depletion in 1980, decreasing to less than one-half by 2020. Livestock water requirements are small and are expected to remain fairly constant. Households and industry uses are expected to increase rapidly.

The second set of water requirement projections is called modified OBERS. This analysis was based on the assumption that population and industrial development would proceed as projected by OBERS and depletions by irrigated agriculture would expand as projected by the state. The state's projection assumed that this expansion would occur because of water imported by the San Juan-Chama Project and by expanding irrigation in the Estancia Ground Water Basin.

The third set of projections was made by the state. State water requirements were based on BBR medium projections of population and economic activities, and assumed that irrigation depletions would expand before other water uses would require the water being used by irrigation. Therefore, the total need for water would amount to irrigation requirement after full development plus the increase in requirements for all other uses.

Table IV-19, page IV-31, shows the water requirements for the three projections. The state projection is the highest of the three and OBERS the lowest. OBERS and modified OBERS share the same non-irrigation requirement estimates. Modified OBERS and state share the same irrigation requirements. State industrial service and household requirements are approximately twice the OBERS level.

For 1980 the OBERS level shows only a small increase over 1967. The state level is more than 100,000 additional acre-feet per year. Modified OBERS 2000 estimates show a need increase of 166,000 acre-feet per year. By 2020 the state projected level is nearly 2.5 times the 1967 estimate, and 73 percent of it is for irrigation and industry.

TABLE IV-19. WATER REQUIREMENTS, 1967 AND PROJECTED, UPPER RIO GRANDE BASIN, NEW MEXICO (ACRE-FEET PER YEAR)

		1980			2000			2020		
	1967	OBERS	MODIF. OBERS	STATE	OBERS	MODIF. OBERS	STATE	OBERS	MODIF. OBERS	STATE
Irrigation	292,940	280,620	348,020	348,020	269,670	363,030	363,030	259,040	353,620	353,620
Livestock	8,270	9,000	9,000	9,000	9,000	9,000	9,000	9,200	9,200	9,200
Industrial/Service	19,310	36,040	36,040	65,560	64,750	64,750	146,980	132,200	132,200	317,660
Household	28,420	37,450	37,450	39,500	73,010	73,010	89,790	143,630	143,630	192,310
Recreation, Fish, Wildlife, and Other	29,600	31,000	31,000	31,000	35,000	35,000	35,000	46,000	46,000	46,000
TOTAL (rounded)	378,540	394,110	461,510	493,180	451,430	544,790	643,800	590,070	684,650	918,890

SUMMARY OF LAND USE REQUIREMENTS

In 1969, there were about 220,700 acres of land developed for irrigation in the basin. By 2020 authorized projects may increase the total by 9,200 acres, and ground water development expected in the Estancia and San Augustine sub-basins would add another 27,100 acres for a total increase of 36,100 acres.

Outdoor recreation land needs for 1980 have been estimated at 169,000 acres over the present level; 496,000 acres for 2000, and 939,000 in 2020.

Urban land needs are expected to increase according to the population projections. In 1963 there were 86,150 acres used for urban purposes in the basin. They are expected to use 133,000 to 167,000 acres in 1980, 211,000 to 315,000 in 2000, and 340,000 to 528,000 by 2020. Based on the OBERS level of population, this could mean a four-fold area increase over 1963.

Land for these uses and for other anticipated purposes is not a limiting factor in the basin.

REFERENCES

Blumenfeld, Arthur A., 1961 - New Mexico Population Since 1910, Bureau of Business Research, University of New Mexico

Bureau of Business Research, 1970 - "New Mexico Business", University of New Mexico

____, 1970 - New Mexico Statistical Abstracts, Vol. 1, University of New Mexico

Bureau of Census - 1960 Census of Population

____ - 1954 Census of Agriculture, Vol. 1, part 3, New Mexico-Arizona

____ - 1964 Census of Agriculture, Vol. 1, part 42, New Mexico

Choate, Grover A., 1966 - "New Mexico's Forest Resource", U. S. Forest Service Resource Bulletin INT-5

Edgel, Ralph L., Undated - "Projections of the Population of New Mexico and its Counties to the Year 2070", Bureau of Business Research, UNM

Intermountain Forest and Range Experiment Station Research Paper INT-34, 1967 - Skiing Trends and Opportunities in the Western States

Lower Colorado Region State Federal Interagency Group for the Pacific Southwest Interagency Committee, Lower Colorado Region Comprehensive Framework Study, 1972

McArthur, Summitt, and Coopedge, Unpublished Manuscript - USDA, ERS, NRED

New Mexico Agricultural Experiment Station, 1965 - Timber-Based Economic Activities, New Mexico 1947-1962, Agricultural Experiment Station Research Report No. 105

New Mexico Department of Agriculture, New Mexico Agricultural Statistics 1950, 1960, 1961

New Mexico Employment Security Commission, 1970, New Mexico County Workforce Estimates, Albuquerque, New Mexico 1960-1968

NMSU Agricultural Experiment Station Bulletin 535, 1968 - Recreational Use and Value of Water at Elephant Butte and Navajo Reservoir

Outdoor Recreation - New Mexico - New Mexico Comprehensive Plan for Outdoor Recreation in North Central New Mexico 1967, 1975, and 1980

Pulp and Papermaking Opportunities in Northern New Mexico, undated - USDA, FS, and Cooperation with Bureau of Business Research, University of New Mexico and New Mexico State Forestry

Rand McNalley & Co., 1969 - Marketing Atlas, 100th Edition, New York

United States Water Resource Council, 1968 - "Preliminary Report on Economic Projections for Selected Geographic Areas 1929 to 2020", Vol. 1, Washington, D.C.

CHAPTER V

Water and Related Land Resource Problems

This chapter covers the causes, extent and frequency, and the economic and social consequences of the water and related land resource problems. The results of the studies are summarized in physical and monetary terms covering the following topics: General Agriculture; Flood Damage; Erosion; Land Use Planning; Impaired Drainage; Water Depletions and Limitations; Wildfire; Fish and Wildlife; Outdoor Recreation; and Pollution.

GENERAL AGRICULTURAL

Agricultural problems are related to small scale production and marketing and to limited land holdings and water resources. Except for some areas supplied by ground water, irrigated land occurs in small tracts, usually lying along stream channels. Surface water supplies are often insufficient to meet water requirements during summer months and during prolonged droughts.

Although farm consolidation is taking place, in 1969, 52 percent of basin farms had sales of less than $2,500, and 80 percent had sales of less than $10,000. Intensively cultivated crops are not grown on most of the farms. This is due to a combination of factors including lack of markets, grading and packing facilities, basic business and technical knowledge, and financing.

Farm products are usually marketed in small quantities or in non-standard grades. These conditions have not justified large, privately financed processing and marketing facilities. Vegetables and orchards show an erratic decline in acres since 1949.

LAND TITLES

A long standing and vexing problem with associated resource use and social and economic impacts is the situation of land title transfers. Often the older land grants are not covered by a master abstract from which subsequent deeds could be drawn. This condition plus unreliable surveys, similarity of names on records, and inadequate or non-existent records has created a situation where costs of clearing land title in some instances has been more than the price of the property.

CROPLAND MANAGEMENT

Farming as a vocation is generally a marginal endeavor except in a few isolated areas with exceptional farmers. Most farmers are part-time, or their farmland is used conjunctively with privately-owned rangeland or public leased rangeland. Some of the problems in the farming business are management, farming technology, and water supply. Management problems are in the areas of capital management, logistics, markets, and resource use. Technology problems involve insufficient quantities of needed fertilizers, inadequate and underpowered farm equipment, and inadequate applications of pesticides and herbicides. Water problems are related to both the quantity available and its seasonal characteristics. Generally, the soils being irrigated are productive and respond to good management, technology, and adequate water supplies.

RANGE MANAGEMENT

Historically, most of the native rangeland was heavily grazed with little or no regard for the physiology of the forage. *"Maximum number of livestock was reached by 1900 with more than 150,000 cattle, more than 1,500,000 sheep and about 50,000 horses, mules, and burros, totaling 533,000 animal units in the New Mexico portion of the basin."* (Dortignac, 1956).

Severity of use compounded by erratic precipitation and fragile soils accounts for accelerated erosion in some areas. Rain is scarce and is often damaging when it comes in large quantities. Vegetative density is insufficient in many areas to protect the soil from wind and water erosion; productivity decreases, runoff increases, channels erode wider and deeper, and the water tables go lower. Stabilization of the soil, the foundation for sustaining the forage resource, is a prime problem. Large areas needing erosion control are marginally suited grazing lands.

Progress in solving range problems is slow because of the limited acceptance, application, and follow-through of improved grazing systems. There is a constant shortage of feed and precipitation each spring, which is the most critical period physically for both plants and animals. Grazing systems are designed to take into account these periods, but the erratic occurrence of droughts has a direct bearing on many ranchers' willingness to invest in the cost of range improvement.

There are about 10.4 million acres of public and Indian lands grazed in the basin. Of this, about 30 percent sustains six or less animal units per section, and 57 percent supports 6 to 12 animal units per section per year (NMSU Agricultural Experiment Station Research Report 158, 1969). It is estimated that 80 percent of the operation is too small to sustain a family livelihood. The operation is often supplemented by a seasonal or welfare income. Ownership of livestock is hereditary, and the commodities are generally used locally.

Constant use has reduced the vigor or eliminated many desirable forage plants, and they are being replaced by junipers, pinyon, pingue, snakeweed, and less desirable grasses and annuals. Some of the undesirable species are toxic. Recovery through management practice will be slow. Success of reseeding is low because of soil and climatic limitations. The exclusion of livestock, for two to three growing seasons, is needed for plant establishment. This creates an economic burden on the owner. Problems of how to supplement incomes during the restoration period are difficult to solve.

FOREST MANAGEMENT

Forest resource problems relating to water are centered around the maintenance of protective cover and soil stability. It is estimated that an average of 20,000 acres are disturbed annually as the result of timber harvesting activities. The degree of disturbance attributed to log skidding, landing, road construction, and methods of harvesting are related to slope, soil, and cover. Inadequate planning of harvesting activities has led to extensive erosion. Much of the sediment produced on forest land comes from sloughing road cuts.

The volume per acre (5,072 board feet, International 1/4-inch log rule) of sawtimber stands in New Mexico is the lowest of any of the Rocky Mountain States (Choate, 1966). When lumber alone is produced, about 22 percent of the tree is used, and the remainder ends up as woods or mill residue (Landt and Woodfin, 1964). Poor quality timber also accounts for the large volume of slash left on the ground. Dry climatic conditions create a fire hazard problem and burning of this slash to reduce the fire hazard creates air pollution problems.

Treatment to control epidemics of insect infestation creates water-related problems. The treatments are often sources of pollution.

Low percentage of regeneration, either natural or artificial, is a constant problem. Heavily cut over and some burnt areas have not been restocked and are not producing timber. The lack of market for the smaller diameter trees (less than nine inches at 4-1/2 feet above ground) presents a problem that has handicapped commercial type thinnings.

Competition among the alternative uses for timber lands and satisfying environmental consideration in management have imposed new problems. Other problems affecting the forest resources include: the high cost of road construction, market locations, location of transportation hubs in relation to sawmills, and the high investment for equipment and supplies.

F L O O D   D A M A G E

Intensive summer thundershowers are the principal cause of floodwater and sediment damage. The current estimated average annual upstream flood damage is $3,224,000 (1969), of which $1,457,000 is to agricultural property and $1,767,000 is to nonagricultural property. If no corrective action is taken, the average annual damage by 1980 is estimated to be $3,600,000; by year 2000, $4,000,000; and $4,400,000 by 2020.

Average annual flood damage projections (1980) to agricultural property are as follows: $1,060,000 to crops and pastures; $230,000 to irrigation systems; and $171,000 to other agricultural lands.

Average annual non-agricultural damage projections (1980) include about $1,593,000 damage to residential, commercial, and industrial property and about $190,000 to transportation facilities.

FLOODWATER

In the 19 potential watershed projects the estimated area of agricultural land subject to flood damage is approximately 29,100 acres. Urban and rural residential areas subject to flooding are approximately 12,700 acres. The total area that would be flooded by a one percent chance of occurrence storm in these watersheds is about 41,800 acres.

PHOTO V-1. FLOODWATER DAMAGE, BELEN, NEW MEXICO, JUNE 1969

PHOTO V-2. MAIN STREET UNDER FLOODWATER, ESTANCIA, NEW MEXICO

PHOTO V-3. SEVERELY GULLIED AREAS CONTRIBUTE TO SEDIMENT IN THE STREAMS OF THE UPPER RIO GRANDE BASIN.

EROSION

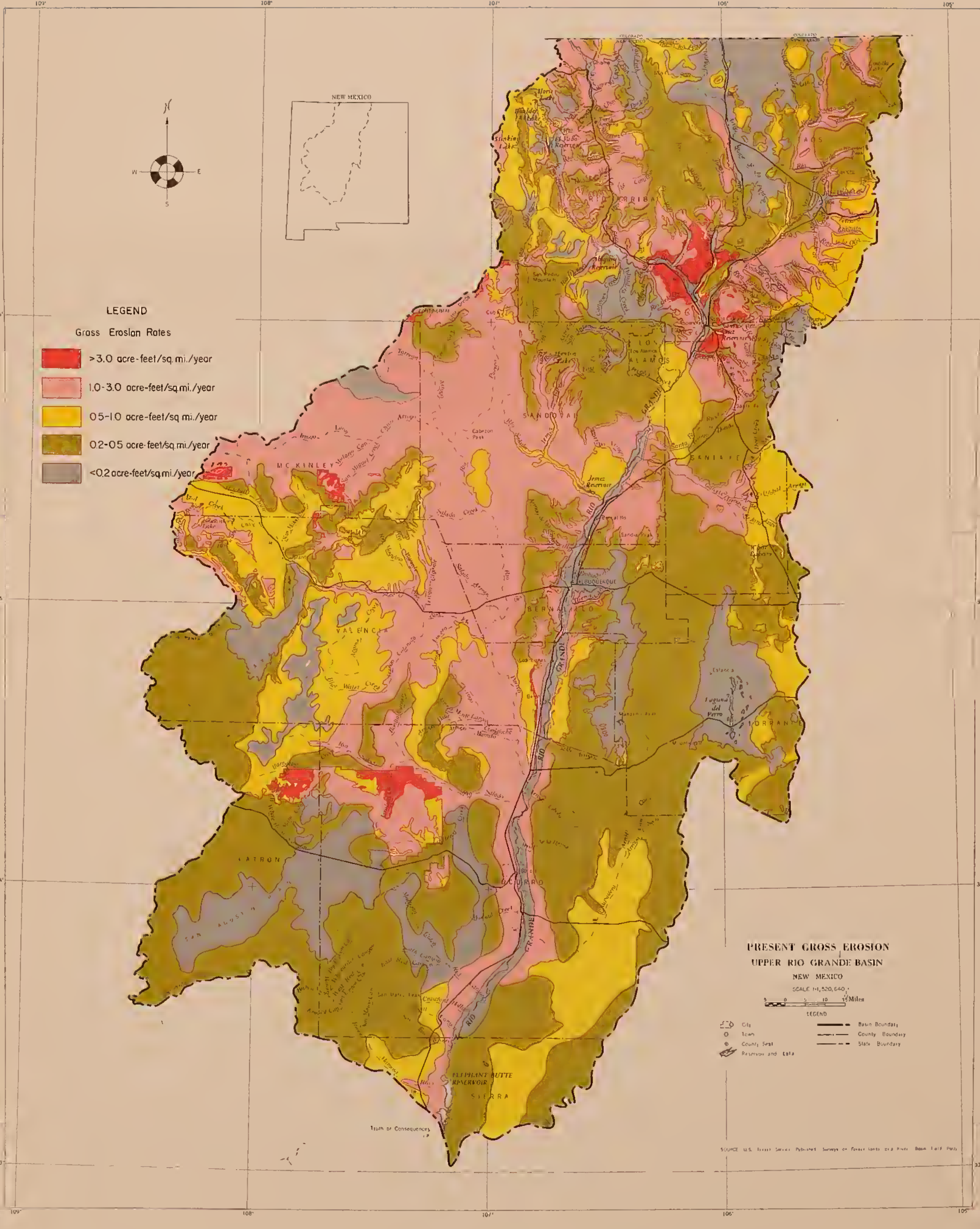
Erosion can be the result of physical landscape factors such as poor soil characteristics, inadequate vegetative cover, steep slope, excessive precipitation, and strong wind. It is estimated that between 13,500 to 36,000 acre-feet of soil is eroded by water each year. Erosion rates vary from less than one to more than seven acre-feet per square mile annually. The present gross erosion rates (includes sheet, rill, gully and streambank) are shown on the Present Gross Erosion Map, facing page V-6; and the maximum erosion to be expected if no management is practiced, is shown on the Erosion Hazard Map, facing page V-8.

A few of the causes of accelerated erosion are: overgrazing, unplanned land promotion, poor logging practices, off-road use of four-wheel drive vehicles and motorbikes on unstable soils, and the establishment and use of erosion-prone primitive roads.

In the basin there are approximately 11,600 miles of unpaved roads (includes primitive, unimproved and graded, and drained roads) and approximately 4,160 miles of paved roads (includes gravel and stone, bituminous, rock asphalt, and concrete roads) (New Mexico State Highway Department, 1968). A major source of erosion is steep, bare road cuts where surface erosion and sloughing take place. Erosion is accelerated when bank toes are undercut by road maintenance equipment. The dirt roads and trails are subject to wind and water erosion. The primitive roads often develop into large gullies.

The effects of erosion are varied and far-reaching. There are interrelated physical, economic, and social consequences. A few of these effects are:

1. Loss of productive land and soil nutrients. It is estimated that it would cost between $12.5 and $33.5 million each year to replace the nutrients lost due to erosion.
2. Decrease in forage production.
3. Reduction in pounds of meat and wool produced due to decrease in forage. Studies also show that crop production is reduced due to loss of topsoil. These consequences reduce the monetary value of the land.
4. Gully development decreases efficiency of operations and also causes a decline in the incentive of owners to improve land.
5. Reduction in recreation activity and wildlife harvest.
6. Sediment damages (deposition) and sediment pollution of water.



PRESENT GROSS EROSION
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
5 0 5 10 15 Miles
LEGEND
City
Town
County Seat
Basin Boundary
County Boundary
State Boundary
LEGEND
Gross Erosion Rates
>3.0 acre-feet/sq.mi./year
1.0-3.0 acre-feet/sq.mi./year
0.5-1.0 acre-feet/sq.mi./year
0.2-0.5 acre-feet/sq.mi./year
<0.2 acre-feet/sq.mi./year
NEW MEXICO
N
W
E
S
109°
108°
107°
106°
105°
36°
35°
34°
33°
MC KINLEY
VALENCIA
SANDOVAL
BERNALILLO
SANTA FE
TORRANCE
CATRON
SAN AUGUSTIN
SIERRA
ELEPHANT BUTTE RESERVOIR
RIO GRANDE
LOS ALAMOS
ALBUQUERQUE
Jemez Reservoir
Truth or Consequences

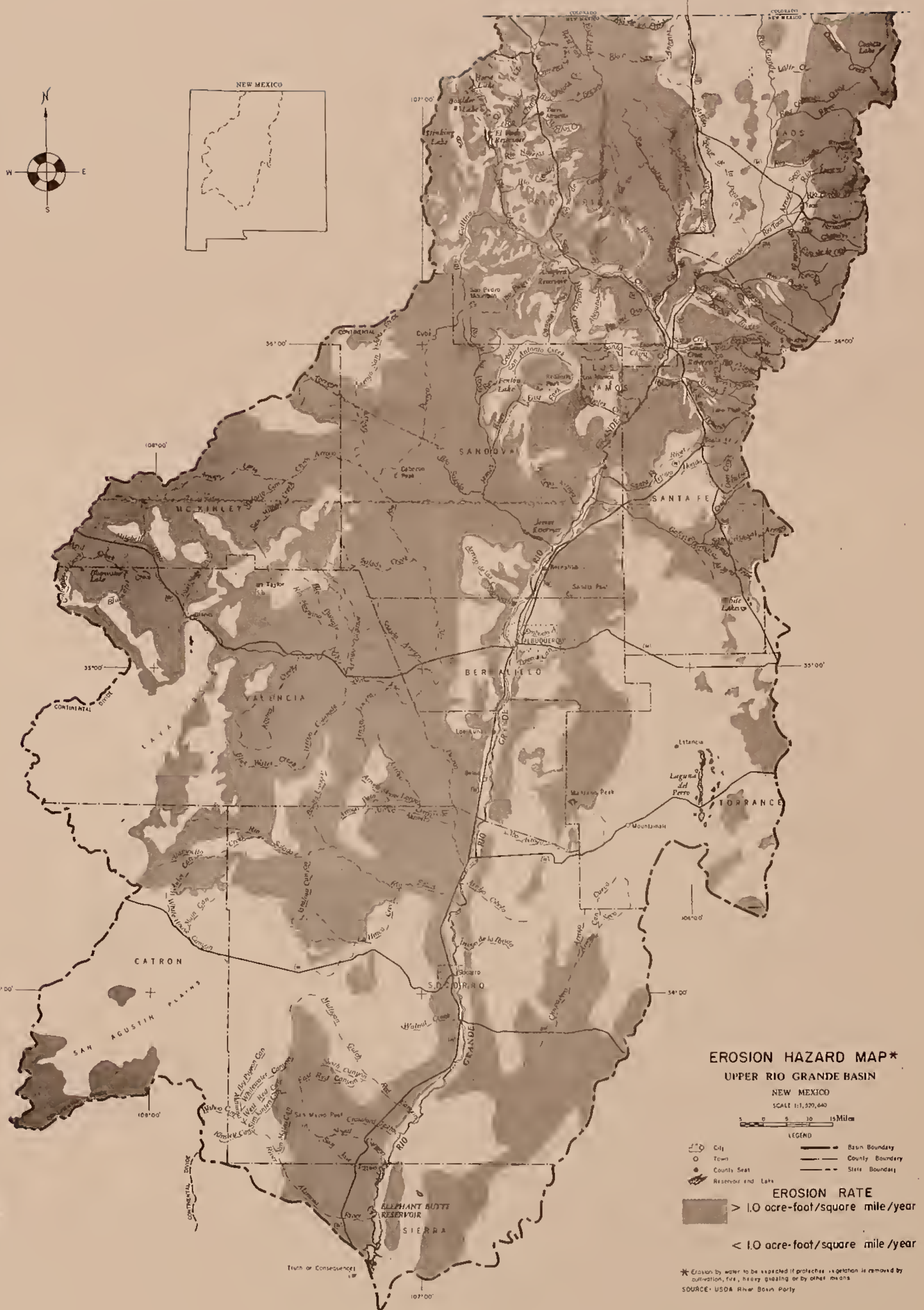
M7-S-21595-N

According to the "Report of the Chief of Engineers to the Secretary of the Army on a Study of Streambank Erosion in the United States" (Committee on Public Works, 1969), there are 101,800 miles of channels in the Rio Grande Water Resource Region. The above data when adjusted to the Upper Rio Grande Basin shows an estimated 27,190·miles of channel. Data in the report indicates that in the Upper Rio Grande Basin there are about 14,600 miles of streambanks with erosion problems; of this amount, 2,715 miles suffer severe erosion. The average annual land loss due to bank erosion is estimated to be $109,470.

PHOTO V-4. STREAMBANK EROSION ON RIO PUERCO PRESENTS EROSION AND SEDIMENTATION PROBLEM

PHOTO V-5. LOOKING EAST FROM IRRIGATION CANAL BANK THAT BROKE DURING STORM IN JUNE 1969 AT BELEN, NEW MEXICO. NOTE SEDIMENT DEPOSITION. SCS PHOTO

PHOTO V-6. SEDIMENT DEPOSITION - TWO FEET OF SEDIMENT AROUND TEN-YEAR OLD COTTONWOOD. (NOTE FOOT RULE NEAR CENTER OF PHOTO). SCS PHOTO 12-P352-9


NEW MEXICO
N
W
E
S
COLORADO
NEW MEXICO
TAOS
RIO ARRIBA
SANDOVAL
LOS ALAMOS
SANTA FE
MC KINLEY
BERNALILLO
VALENCIA
TORRANCE
CATRON
SOCORRO
SIERRA
SAN AGUSTIN PLAINS
RIO GRANDE
ELEPHANT BUTTE RESERVOIR
Laguna del Perro
Estancia
Truth or Consequences
Socorro
EROSION HAZARD MAP*
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
Miles
LEGEND
City
Town
County Seat
Reservoir and Lake
Basin Boundary
County Boundary
State Boundary
EROSION RATE
> 1.0 acre-foot/square mile/year
< 1.0 acre-foot/square mile/year
* Erosion by water to be expected if protective vegetation is removed by cultivation, fire, heavy grazing or by other means
SOURCE: USDA River Basin Party

4-R-34721

SEDIMENT

Damaging sediment is deposited on agricultural land, in irrigation canals, along streams and arroyos, and in reservoirs. Sediment deposited in highway culverts and arroyo channels increases the possibility of overbank flooding and damage. It is thought (Dortignac, 1956) that high erosion and subsequent heavy concentrations of sediment in the river waters result in an increase in salt content downriver.

Some concept of the amount of erosion and subsequent sediment transported may be realized when suspended sediment data is analyzed. Table V-1, page V-10, presents the volume of sediment transported in the Rio Chama, Rio Puerco, Rio Salado, and Rio Grande during water years 1948 through 1965.

Table V-1 indicates that at least 19.5 million tons of sediment remained in the reach of the Rio Grande between Bernalillo and Bernardo gages. The sediment gaged into the Bernardo to San Acacia reach was 197.4 million tons (Bernardo plus Rio Puerco and Rio Salado), yet only 167.2 million tons were gaged at San Acacia indicating that at least 30 million tons remained in that reach. At least 58.5 million tons remained in the San Acacia to San Marcial reach. Analysis of the data indicates that in the 18-year period, over 108 million tons of sediment were deposited in the channel of the Rio Grande, irrigation canals, cropland and floodplains, etc., and should be considered damaging sediment.

High concentrations of suspended sediment are damaging to fish and wildlife and associated recreation as well as the beauty of the river. Concentrations of more than 3,000 parts per million are considered dangerous to fish if sustained for a period of 10 days or more (Kemp, 1949). Concentrations of this intensity and extent are a yearly occurrence on reaches of the Rio Chama and the Rio Grande above Elephant Butte Reservoir.

An example of sediment damage to irrigated land was emphasized by suspended load samples taken from the Rio Chama during the irrigation season of 1964. The sediment concentration was as high as 58,500 parts per million. The sediment-laden water was diverted from the Rio Chama and sediment was deposited in canals and on irrigated land.

TABLE V-1. SUSPENDED SEDIMENT DATA - UPPER RIO GRANDE BASIN, NEW MEXICO (1948-1965 WATER YEARS)

Gaging Station 1/	Total Acre-Feet of Suspended Sediment Passing Gage 5/	Total Tons of Suspended Sediment Passing Gage 2/
Rio Chama near Chamita	22,117	31,295,395
Rio Grande at Otowi Bridge near San Ildefonso	32,742	46,330,490
Rio Grande near Bernalillo	52,764	74,660,705
Rio Grande near Bernardo	38,820	54,930,553
Rio Grande and Rio Salado tributary to Rio Grande 4/	100,688 3/	142,472,915 3/
Rio Grande at San Acacia	118,191	167,240,000
Rio Grande at San Marcial	76,825	108,706,908

1/ Stations listed in downstream order.
2/ (V. W. Norman, 1968).
3/ Several years estimated.
4/ Rio Puerco and Rio Salado are tributaries to the Rio Grande in the Bernardo-San Acacia reach.
5/ Use 65.0 pounds equals one cubic foot or one acre-foot equals 1,415 tons (communication with Mr. Lasen, Sedimentation Section, U. S. Corps of Engineers, Albuquerque, New Mexico)

LAND USE PLANNING

One of the problems of proper land use is the lack of basic data. Soil surveys, for example, are lacking on about 12 million acres in the Upper Rio Grande Basin.

The public spends billions of dollars each year for flood prevention and protection, yet flood damages increase. The lack of comprehensive and functional land use plans and zoning ordinances allows the continued development of areas that are subject to flooding.

Unplanned and unregulated expansion of existing municipalities, as well as the thousands of acres of "raw" lands that are being subdivided by transit and motor grader and then sold far afield, pose serious problems of road erosion, future higher taxes, costly utilities and services to basin taxpayers.

IMPAIRED DRAINAGE

About 37,900 acres of irrigated land are affected by high-water table and salt and/or alkali (sodium) accumulations that restrict crop growth. About 16 percent of this acreage is severely affected, 30 percent moderately affected, and 54 percent slightly affected. There are three major causes of a high-water table:

1. Sediment deposited in the river bed.

2. Seepage loss from canals and laterals. (In some instances, as high as 20 percent per mile).

3. Excessive irrigation.

A high-water table decreases crop production by about one-third and leaches costly nutrients from the soil. The water table level fluctuates from season to season and is nearest the ground surface during the time of peak river flow and heaviest irrigation.

In the Lyden area, north of Espanola, floodwaters pond on agricultural lands due partly to the lack of maintenance of a system of surface drains established about 30 years ago.

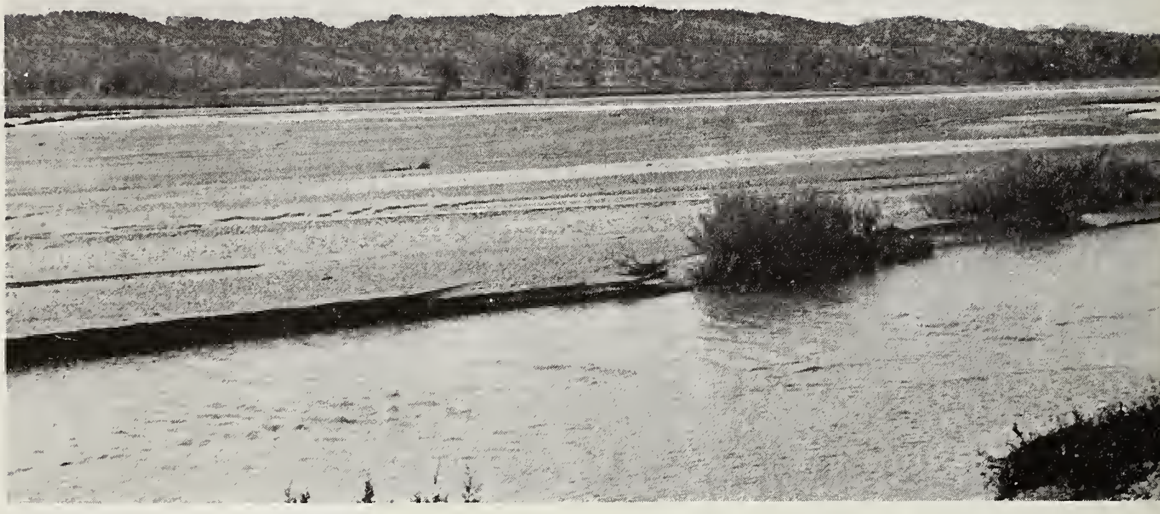


PHOTO V-7. 1936 PHOTO TAKEN FROM TECHNICAL REPORT ON "SOIL AND EROSION SURVEY", SAN JUAN PUEBLO GRANT SCS PHOTO 12-6740

PHOTO V-8. 1967 PHOTO TAKEN OF IDENTICAL AREA TO COMPARE WITH PHOTO TAKEN IN 1936. NOTE INCREASE IN PHREATOPHYTES. SCS PHOTO 12-P443-8

WATER DEPLETIONS AND LIMITATIONS OF SUPPLY

Wet and dry periods are characteristic of the basin. Prior to 1946, precipitation and runoff were generally above the 1921-1950 normal. Since 1946, both precipitation and runoff have been below normal.

Much of the summer precipitation falls as torrential rainstorms. The rest occurs as snow or light showers. Only about 5.9 percent of the yearly precipitation becomes streamflow. The rest is lost through evaporation and transpiration of plants. Most of the tributary streamflows are insufficient to supply irrigation requirements during June, July, and August. Figure V-1, page V-10, is a typical example of the monthly streamflow distribution and irrigation diversion demand of a tributary area. The major streamflow of tributaries occurs in April and May each year from snowmelt, whereas the peak diversion requirement for irrigation occurs during June, July, and August.

BRUSHLAND AND WATER USE

About 6,240,000 acres of grazing land are infested with woody or brush vegetation. These woody or brush species use about 27,300 acre-feet of water annually. Principal species are pinyon-juniper, sagebrush, creosotebush, cholla cactus, and mesquite.

Brush, usually of little economic value, is often an extremely high and inefficient user of water. Research in Arizona shows that mesquite trees use 1,725 pounds of water to grow a pound of dry matter, while blue grama grass requires only 596 pounds of water. Texas studies found that mesquite stands with a 50 percent canopy cover can use nine acre-inches of water a month during the growing season (Hoffman, 1967).

Brush-infested areas result in deterioration of useful forage for livestock and wildlife, increase the erosion hazard, and increase the cost of handling livestock.

Two photos (page V-12) taken 30 years apart, reveal: (1) a 25 percent increase in canopy exposure; and, (2) a 12 percent increase in brush ground cover. This constant increase in brush and woodland density makes the loss of moisture an increasing problem.

Phreatophytes are water-loving plants with their root systems close to the water table. Saltcedar (tamarisk), salt grasses, russian olives, and cottonwood trees are examples. Phreatophytes occur in all regions of the United States, but they cause the greatest problem in areas of limited water supplies in the southwest (Blaney, 1961). These plants spread rapidly and consume large quantities of water. In addition to

depletion of limited water supplies and displacement of more desirable vegetation, phreatophytes often choke stream channels, causing accelerated deposition of sediment in channels, thereby increasing the frequency and severity of overbank flooding. However, these plants provide wildlife habitat and are considered scenic by some persons.

Phreatophyte acreages have nearly doubled in 31 years, and plant density is much greater. Saltcedar and cottonwoods use from 50 to 100 percent more water than most agricultural crops. The basin had approximately 74,500 acres of bottomland infested by phreatophytes in 1960.

The annual consumptive use of water by these plants is about 256,280 acre-feet. The value of this water, if used for irrigation, is about $4,484,900. Table V-2 indicates acres, water use, and value of water for 1960 and projections for 1980, 2000, and 2020 if no control measures are taken.

TABLE V-2. PHREATOPHYTE AREA, CONSUMPTIVE USE, AND WATER VALUE IF ONE-HALF COULD BE USED FOR AGRICULTURE

Year	Area (Acres) 1/	Consumptive Use (Acre-Feet) 2/	Value of Water If Used for Agriculture 3/
1960	74,500	256,280	$4,484,900
1980	84,500	290,680	5,086,900
2000	96,500	331,960	5,809,300
2020	111,500	383,560	6,712,300

1/ Assuming no control measures are taken.
2/ Consumptive use = 3.44 acre-feet per acre.
3/ Average value of water in Rio Grande @ $35 per acre-foot. Assume one-half of the water used by phreatophytes could be salvaged. (Average of USBR of $26 for Upper Rio Grande Basin and $44 for Middle Rio Grande Basin).

Projections made by River Basin Field Party.

AGRICULTURAL CROPLAND

There are three general types of water problems for agricultural uses:

1. An annual lack of sustained late season streamflow on tributaries.

2. The inability to deliver water through canal systems due to flood damages.

3. Inefficiencies in conveyance systems and on-farm use.

Inadequate streamflow occurs during the peak irrigation season in many areas. In some cases the average annual runoff from the tributary areas would be sufficient to meet irrigation requirements if the streamflows were regulated.

Figure V-1, page V-10, is an example of typical streamflow and irrigation requirements on the tributaries. It shows that the streamflow exceeds the irrigation requirement in April, May, and part of June, and is less than the requirement the latter part of June and the months of July, August, and September. The shortage of water in July, August, and September reduces by about one-third the quantity of hay that could be produced each year with a full water supply and causes a reduction in the quantity and quality of other crops that are grown. Water shortage restricts planting crops that would yield higher returns than some of those presently grown.

On the average, about 654,880 acre-feet of water flows past Elephant Butte Dam for use in New Mexico, Texas, and Mexico. For a more detailed breakdown of water depletions see Tables III-3, page III-13, and V-3.

More than 600 irrigation diversion dams and ditches serve the irrigated areas in the floodplains. These dams are generally inefficient log or brush and rock structures placed in the stream to divert the water into irrigation ditches. Water control structures in ditches are usually of wood or earth, and turnouts usually consist of holes cut through ditch banks.

Surface water in the basin is fully appropriated. The irrigated land along the Rio Grande from Cochiti to San Marcial has in the past experienced a shortage of water for irrigation due to erratic streamflows.

Ground water along the river is generally in sufficient quantity to supplement surface irrigation. However, ground water withdrawals directly affect streamflows; therefore, ground water development is controlled by the state to protect existing rights along the stream.

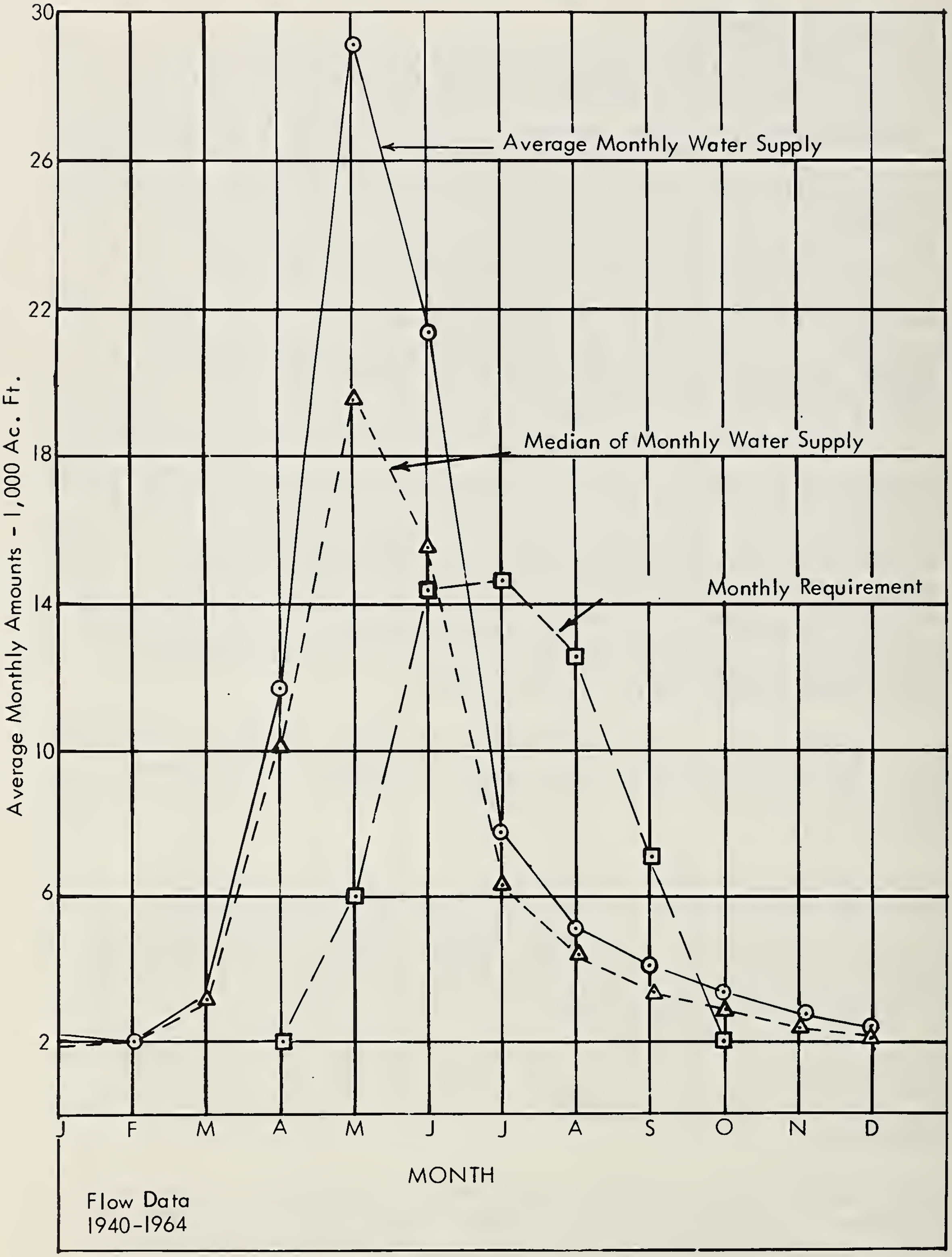


FIGURE V-1. WATER SUPPLY AND IRRIGATION WATER REQUIREMENT
TAOS-RIO HONDO AREA, TAOS COUNTY, NEW MEXICO

TABLE V-3. SUMMARY OF ESTIMATED SURFACE WATER DEPLETIONS, UPPER RIO GRANDE BASIN, NEW MEXICO (ACRE-FEET), EXCLUDING ESTANCIA SUB-BASIN

By River Reaches	Total Depletion (Acre-Feet)	Approximate Percent Non-Beneficial Depletion
Lobates-Taos Junction	62,180	13
Taos Junction-Embudo	12,700	16
Embudo-Otowi	93,200	31
Otowi-San Marcial	578,970	58
San Marcial-Elephant Butte Dam	110,460	99
TOTAL	857,510	57

A significant amount of ground water is being used for irrigation in the Estancia Sub-Basin where about 32,400 acre-feet in 1969 were depleted for irrigation. The water table in some areas is declining.

PHOTO V-9. TYPICAL IRRIGATION DITCH TO SMALL FARMS

SCS PHOTO 12-P615-16

PHOTO V-10. WOODEN FLUME FOR TRANSPORTING IRRIGATION WATER.

SCS PHOTO 12-P799-15

MUNICIPAL AND LIVESTOCK

TABLE V-4. COMMUNITIES WITH MINERALS IN WATER SUPPLY IN EXCESS OF UNITED STATES PUBLIC HEALTH SERVICE STANDARDS 2/

Community	Iron	Nitrate	Fluoride	Sulphate	Total Dissolved Solids
Bluewater				X	X
Cebolla	X				
Cedar Grove	X		X		
Chama			X		X
Cuba	X				X
Elephant Butte Estates			X		X
Encinal				X	X
Espanola 1/	X		X		X
Golden Acres				X	X
Grants				X	X
Jemez Pueblo	X				
Lemitar	X			X	X
Llano Chimayo			X		X
Los Ranchos de Albuquerque	X				
Madrid	X			X	X
Mesita				X	X
Montecito			X		
Moquino				X	X
Moriarty	X			X	X
Old Laguna				X	X
Paraje				X	X
Polvadera		X		X	X
San Antonio				X	
San Mateo			X		X
San Rafael				X	X
Santo Domingo				X	
Seama				X	
South Ojo Caliente				X	X
Skyview Acres	X				
Tijeras	X				
Thoreau	X				
Tres Piedras	X				
Veguita		X			
Vista Redondo			X		X

1/ Not all municipal wells contain excess minerals.
2/ NM Water Supply Chemical Data - Major and Minor Communities - Environmental Improvement Agency - 1974.

In addition to the communities shown in Table V-4, the following communities' water supplies have total dissolved solids in excess of 500 mg/l: Adobe Acres, Belen, Canjilon, Canyon, Capulin, Chimayo, Coyote, Cubero, Lindrith, Lumberton, Ojo Caliente, Placitas (Rio Arriba), and San Ysidro.

As the requirements for municipal water increase, obtaining the water and developing the works required to assure an adequate supply will become a major problem. As of 1966 there were 42 communities with populations of 100 or more that had no water system or had a system that would be inadequate for the 1985 projected populations. It is questionable that Acoma Pueblo, Los Alamos, Magdalena, Tijeras, and Tres Piedras will have adequate ground water resources for the expected 1985 population. In some villages minerals in the water are in excess of drinking water standards set by the United States Public Health Service (see Table V-4, page V-19). Inadequate distribution of livestock water causes range management problems.

WILDFIRE

Wildfire will remain a constant threat as the forests accommodate more users annually. The frequency of fires fluctuates from year to year. Fire records for the period 1961-1970 averaged 261 fires, burning 1,205 acres per year. Intensified fire control efforts have reduced the size of individual fires.

There is physical evidence of devastating fires occurring in the high country of the basin. Such a fire can set back productivity many years. The intensity of a fire is directly related to the type and concentration of fuels. It is estimated that 20 percent of all wildfires are caused by man.

FISH AND WILDLIFE

The effects of man's past activities and land use practices have harmed the habitats of fish and wildlife. Long periods of heavy grazing by domestic livestock have resulted in the reduction of forage plants utilized by wildlife. Increased runoff rates and the accompanying sediment yields that have resulted from degraded range conditions have adversely affected aquatic habitats.

Expansion of the human population and the great increase in recreational activities that have brought people into remote areas have generated conflicts and competition with the historical use of these areas by wildlife. Man-caused pollution in the forms of sediments, mining wastes, and domestic sewerage has lowered the capacity of aquatic ecosystems to support desirable fish populations.

Water-borne residues from agricultural pesticides and chemical fertilizers, industrial and commercial wastes, and irrigation diversions are affecting the streams and rivers in the area.

PHOTO V-11. SUPPRESSION ACTION ON BRUSH FIRE SCS PHOTO

OUTDOOR RECREATION

There is a problem in insufficient facilities for picnicking and camping, which is expressed by the overcrowded condition of many camping and picnicking areas. There are insufficient recreation parks in urban areas and natural scenic parks and recreation areas near cities. As the population increases, the pressure on existing facilities will increase.

POLLUTION

Within the basin are many miles of high mountain streams containing clean water, many square miles of practically untouched land, and the air at present is reasonably pure. In the lower elevations where man makes his home pollution becomes more of a problem. Rivers contain large quantities of sediment as a result of accelerated erosion, lands have had a history of heavy grazing, some areas are denuded of vegetation due to land development, and the air of metropolitan areas is polluted with dust and automobile fumes.

WATER

Water in most of the streams at the lower elevations is polluted and not considered potable. This is due to discharging sewage effluent from towns and communities that have insufficient or no sewerage treatment plants, effluent from mining operations being accidentally returned to the streams without proper treatment, and use of insecticides and commercial fertilizers. At times some of these pollutants are in quantities considered harmful to fish, wildlife, and man. Table V-5 gives an indication of the water quality and chemical content in the Rio Grande. The quality meets state water quality standards for this reach. Total dissolved solids increase in a downstream direction, 220 milligrams per liter at state line, to 447 milligrams per liter at San Marcial. Chemical content in surface water does not present a problem at the present time.

One of the principal problems of water quality is associated with land erosion (New Mexico Water Quality Control Commission, 1967). Major sediment contributing areas are shown on the Present Gross Erosion Map, facing page V-6. Removal of high concentration of sediment in domestic and industrial water is costly. Sediment concentrations of such magnitude and frequency as to be detrimental to fish occur yearly on the Rio Grande and Rio Chama. A high concentration of sediment detracts from the scenic beauty of streams and can be a detriment to recreation use. In some cases, the sediment-laden irrigation water reduces crop yields.

TABLE V-5. TOTAL DISSOLVED SOLIDS CONSTITUENTS - 1956-1965 WEIGHTED AVERAGE

Basin & Station	Ca Mg/l	Ca %	Mg Mg/l	Mg %	Na Mg/l	Na %	HCO_3 Mg/l	HCO_3 %	SO_4 Mg/l	SO_4 %	Cl Mg/l	Cl %	NO_3 Mg/l	NO_3 %	TDS1/ Mg/l
Rio Grande															
Culebra	31	11.3	6.3	2.3	24	8.7	109	39.6	--	--	--	--	--	--	220
Otowi	43	15.0	6.0	2.1	19	6.6	136	47.5	53	18.5	6.1	2.1	1.0	0.3	217
Bernardo	59	14.3	7.5	1.2	36	8.7	171	41.3	88	21.3	17	4.1	1.5	0.4	353
San Marcial	69	12.7	10	1.8	58	10.7	188	34.7	--	--	--	--	--	--	447
Range:															
From	31		6.3		24		109		53		6.1		1.0		217
To	69		10		58		188		88		17		1.5		447

Note: Percentage of constituents is based on computed quantity of constituents present prior to drying the water sample. (See page 218, "Study and Interpretation of Chemical Characteristics of Natural Water, U.S.G.S. Water Supply Paper 1473.)

1/ TDS is based on weight of dry residue remaining after evaporation of a water sample.

According to Dortignac (1956), *"The increase in salt content in going downriver is, no doubt, partially due to the high silt-laden surface waters...The increase in salt content is concomitant with that of sediment."* The salt burden of the Rio Grande water increases downstream to San Marcial where it exceeds one-half million tons annually. On much of the irrigated farmland below Elephant Butte Reservoir, crop yields are reduced 10 to 20 percent due to salinity (estimate made by Dortignac, 1956). The value of all farm products sold in Sierra and Dona Ana Counties, New Mexico (below Elephant Butte Reservoir) was $30 million (1964 Census of Agriculture). If salinity constitutes a constraint on production of 10 to 20 percent, then salinity constrains economic growth and development by three to six million dollars a year in the irrigated area immediately below the basin.

In some areas the bio-chemical oxygen demand, chemical oxygen demand, and settleable solids in water exceed that considered allowable by state water quality standards (Wright, 1970). Suds from detergents are noticeable in some reaches of the Rio Grande from Albuquerque to the headwaters of the Elephant Butte Reservoir.

PHOTO V-12. PROPER LAND USE REGULATION AND SOLID WASTE CONTROL WOULD PREVENT UNSIGHTLY SCENES SUCH AS THIS

SOLID WASTE

The solid waste generation in the basin was estimated at 312,000 tons in 1970 and will increase to 1,206,000 tons by the year 2020 as indicated in Table V-6.

TABLE V-6. SOLID WASTE OF UPPER RIO GRANDE BASIN, NEW MEXICO (FIELD PARTY PROJECTIONS)

Year	Tons Per Day	Tons Per Year
1970	850	311,900
1980	1,170	427,000
2000	2,050	748,200
2020	3,300	1,205,500

AIR

Motor vehicles, industrial activity, and dust storms all contribute to the problem of air pollution in the basin. According to a recent study (Molzen, 1970) the area between Bernalillo and Belen is developing air pollution problems as the population increases. This study states the following about the Albuquerque area: *"Since atmospheric inversions occur on approximately 90 percent of the winter days in Albuquerque, this area (the valley) is regularly blanketed under the pollution trap.*

The particulate levels account for less than three percent of the emissions from man-made sources. This figure is the total weight of particulates emitted from smokestacks, exhaust pipes, and industrial processes. Dusty roads, vegetation-bare rights of way, vacant lots, construction projects allowed to remain unfinished for extensive time periods, and many other examples contribute to particulate pollution and are not reported in this inventory. Albuquerque has a problem of potentially major proportions with respect to particulate pollution."

REFERENCES

Blaney, H. F., 1961 - Consumptive use and water waste by phreatophytes in Western United States: (Provisional). Paper prepared for Irrigation and Drainage Division Session of the ASCE Convention, April 10, 1961, Phoenix, Arizona.

Choate, Grover A., 1966 - "New Mexico's Forest Resource", U. S. Forest Service Resource Bulletin INT-5.

Committee on Public Works, 1969 - House of Representatives 91st Congress 1st Session, October 1969

Dortignac, E. J., 1956 - "Water Resources and Problems of the Upper Rio Grande Basin", USDA Forest Service Rocky Mountain Forest and Range Experiment Station.

Hoffman, L., "Down to Earth", Volume XXII, No. 4, Spring 1967.

Kemp, H. A., 1949 - Soil Pollution in the Potomac River Basin: Journ. AWWA.

Landt, E. F., and Woodfin, R. O., 1964 - Sawmill and Logging Residue from Ponderosa Pine Trees in the Black Hills, Rocky Mountain Forest and Range Experiment Station, USFS Research Note RM-23.

Molzen, D. F., and Associates, Inc. and Engineering, 1970 - Science Inc., and Department of Environmental Health, City of Albuquerque: Central New Mexico Region Solid Waste Management Study, Appendices, Vol. 2.

New Mexico State University Agricultural Experiment Station Research Report 158, 1969 - Grazing Capacities and Selected Factors Affecting Public Land Use.

New Mexico State Highway Department, 1968 - "Road and Street Mileage in New Mexico", Planning and Programming Division, Bureau of Public Roads, January 1968.

New Mexico Water Quality Control Commission, 1967 - "Implementation and Enforcement Plan for Water Quality Control in New Mexico", Santa Fe, New Mexico.

Norman, V. W., 1968 - Trends of Suspended Sediments in the Upper Rio Grande Basin in New Mexico: Master's Thesis, University of New Mexico.

Wright, John, 1970 - 1970 hearings on Water Quality Standards for the Rio Grande below Cochiti Reservoir.

CHAPTER VI

Present and Future Needs For Water and Related Resource Developments

This chapter addresses the social and economic needs of the basin. The general agricultural needs include those for irrigated cropland, rangeland, forest land and livestock. Watershed protection and management, flood prevention, land stabilization, drainage improvement, water needs, irrigation, and community water supplies are also considered in terms of their needed improvements. Controlling wildfires, supplying habitats for fish and wildlife, providing outdoor recreation facilities, pollution control, and power supply are also needs of the basin.

ECONOMIC AND SOCIAL

A 1980 occupation-labor matrix estimated by the Bureau of Labor Statistics shows that nationally 44 percent of the labor needs will be for skilled people, 40 percent for semi-skilled, and 16 percent for unskilled workers. Training is needed to develop skills for future labor needs.

An important educational need concerns the present and future water and land users. Vocational agricultural education programs need to be developed, emphasizing the techniques in good water and land management for use in the basin.

Other needs include more public facilities such as sewerage systems, libraries, and medical facilities in the rural areas. Also, a recent study (Liefer, 1970) has indicated that residents of north central New Mexico would support a state-sponsored title clearance program.

Eldon G. Marr (1967), writing on the effect of technology on agriculture, comes to these conclusions, which shed some light on social needs of the basin. *"Although New Mexico appears to be in the last stages of eliminating the small farm, there are enough people living and working on marginal farms to warrant some action for their relief. Without such help they will eventually be pushed off their farms and ranches by the forces of technology, and they will land on the unemployment rolls. The state, of course, will then suffer a greater welfare burden, but this burden is only a small portion of the total social cost of the loss of their farms by these people. Most of the cost to society is borne by those persons whose lives are completely disrupted by having to move from the farm to the city. Certainly, total agriculture output in the state can be increased by consolidating our marginal farms into larger, more efficient units; but whether the social benefits to be derived from this additional increment of production outweigh the costs to our society of losing the cultural heritage and the social traditions of the displaced people is questionable. No price can be placed on such losses, because they are not commodities that can be found in the market."*

GENERAL AGRICULTURAL NEEDS

Some general agricultural needs suggested to alleviate problems are:

1. A study of the possibilities and impacts of consolidating small farms and farm units into larger, more efficient ones. Machinery cooperatives may allow small farmers to operate at lower costs and greater efficiency.

PHOTO VI-1. HIGH COUNTRY FARM FAMILIES OFTEN DEPEND ON NATIONAL FOREST GRAZING FOR THEIR LIVELIHOOD

US FOREST SERVICE PHOTO

2. A study of soil, climate, water restrictions, and potential for replacing low value crops by high value crops on small farm units. This would be useful to basin farmers interested in increasing their incomes and more fully utilizing their time. Portions of the information needed for such a study are already available through the State Experiment Station and Soil Conservation Service. There are about 12 million acres that need soil surveys to be used as an aid in planning and conservation work.

3. A study of the volume of farm output needed to support various processing and marketing facilities would complement the recommended study of physical production possibilities.

4. Marketing cooperatives would also help increase the volume and stability of available products and standardize grading. There is an apple marketing co-op at Chimayo, but its success has been limited by low quality products and the severe 1971 freeze, which killed many trees.

5. Marketing may also be improved via a greater effort to sell products locally as price and quality allow. "Farmers' Markets" may offer potentials for small farmers who sell retail.

IRRIGATED CROPLAND

The needs for cropland depend on the development level considered. Under the state projections, about 54,000 additional acres of developed land will need irrigation water by the year 2020. Under the OBERS projections an additional 21,000 acres will be needed. (Note that there is a difference between irrigated land and land developed for irrigation. Because not all land developed for irrigation receives water, irrigated land is less than land developed for irrigation. See Table IV-16, Page IV-19.)

TABLE VI-1. PROJECTED IRRIGATED LAND NEEDS* - UPPER RIO GRANDE BASIN

Year	State Projected Need	OBERS Projected Need
	Acres	Acres
1980	34,200	0
2000	53,500	9,000
2020	54,200	21,000

* Projected need equals the projected irrigated acreage less 1969 irrigated acreage. See Table IV-16, page IV-19.

RANGE

There is a need for reconnaissance soil surveys with range site interpretations to determine the range capabilities of production. The more productive areas should have the highest priority of treatment.

The recovery of abused rangeland is slow and depends on the degree of soil deterioration. Continued demonstration of proper use of grazing systems and following through of range management plans are needed to alleviate range deterioration. Technical assistance is needed to promote a better understanding of the physiology of the desired range plants and site relationships. In some cases it may be necessary to favor unpalatable species for the purpose of maintaining vital cover on the watershed and to discourage grazing use.

There is a need to study the advantages of forming livestock associations and corporations in order to combine the numerous small operations into larger ones for the purpose of upgrading the rangeland. There is a need to demonstrate the advantage of using the grazing habits of sheep versus cattle for range improvement. Another need is to select various breeds of livestock based on their grazing habits that best adapt to the overall objectives.

There is a need to provide a sustained yield of forage at the time it is needed without deteriorating the vegetal base and the ecosystem on which it exists. Additional fences and watering places are needed to regulate grazing use.

LIVESTOCK

In 1959-1961, it was estimated that 11,166,000 pounds (live weight) of beef and veal were slaughtered in the basin. In 1980, 2000, and 2020, it is projected by OBERS that 17,100,000; 22,800,000; and 29,800,000 pounds of beef and veal for these time periods, respectively, will be the basin's share of the national demand. This demand can be met and surpassed with range and irrigated crop production by converting some of the acreage now producing hay and silage to grain production.

An alternative livestock production possibility was analyzed. Basin projected population (OBERS based) multiplied by per capita demand for livestock products was estimated and is shown in Table VI-3, page VI-5. Table VI-4, page VI-5, shows the irrigated land and water required to produce the livestock needs in the basin.

TABLE VI-2. ESTIMATED ACRES OF IRRIGATED LAND AND WATER TO PRODUCE CROPS FOR BEEF

Year	Projected Demand Beef (pounds) 1/	Irrigated Acres to Produce Fat Beef 2/ Grain	Hay	Silage	Total Irrigated (Acres)	On Farm 3/ Water Requirement (AcFt)
1960	11,166,000	45,900	5,400	7,020	58,320	99,140
1980	17,100,000	29,560	4,466	4,968	38,994	66,290
2000	22,800,000	29,593	4,371	5,165	39,129	66,520
2020	29,800,000	35,700	4,200	4,900	44,800	76,160

1/ OBERS based projected demand for beef (live weight)
2/ Based on 1964 Agriculture Census: Acreages of crops were determined by dividing feed needs of cattle by crop yields.
3/ Based on average crop irrigation requirement for forage and feed grain crops of 1.3' and a farm loss of 0.4 acre-feet per acre.

TABLE VI-3. ESTIMATED CONSUMPTION OF LIVESTOCK PRODUCTS IN THE BASIN 1/

Year	Meat Carcass Weight in Thousand(s) Lbs. Beef	Pork	Mutton	Chicken	Turkey	Eggs 1000 doz	Milk 1000 lb
1980	74,482	41,697	2,228	21,963	7,003	15,385	362,862
2000	110,249	61,721	3,298	32,509	10,365	22,772	537,111
2020	171,534	96,030	5,131	50,580	16,127	35,431	835,679

1/ Based on OBERS national projected per capita use and basin population

TABLE VI-4. ESTIMATED ACRES OF IRRIGATED LAND AND WATER TO PRODUCE LIVESTOCK NEEDS OF THE BASIN

Year	Acres of Irrigated Land Required Beef	Pork	Mutton	Chick.	Turkey	Eggs	Milk	Total	Water 1/ (Ac. Ft.)
1980	188,100	209,600	4,500	30,900	17,000	24,400	60,500	535,000	909,700
2000	242,500	281,000	5,800	39,600	21,000	31,200	79,000	700,200	1,190,000
2020	334,200	392,800	8,000	54,600	29,200	43,300	104,400	966,500	1,643,000

1/ On farm water requirement based on average CIR for forage and feed grain crops = 1.3' and a farm loss of 0.4 acre-feet per acre

FOREST

The anticipated shrinkage of timber land base and the expected increase in demand for wood products indicate a need for an accurate basin inventory to determine volume, stand condition, age class distribution, and productivity. Inventories are lacking, particularly on the non-federally owned lands.

There is a need to assure regeneration, natural or artificial, of the species being harvested because of some of the difficulty encountered in their reestablishment. Implementation of improved harvesting practices and equipment is needed to minimize the disturbance of soil mantle.

There is a need to maximize the use of waste resulting from low quality trees. Table VI-5 shows the comparison of water requirements for various pulping processes.

TABLE VI-5. REPORTED MAXIMUM AND MINIMUM FRESH WATER REQUIREMENTS FOR SELECTED PULPING PROCESSES

Process	Gallons of Fresh Water Required per ton of Pulp	
	Maximum	Minimum
Pulping:		
Kraft (sulfate) and soda	88,500	33,000
Sulfite	79,000	8,300
Groundwood	69,000	1,000
Semichemical (neutral sulfite)	12,400	6,980
Pulp Bleaching		
Kraft (sulfate) and soda	56,000	6,500
Sulfite	47,300	-
Groundwood	23,400	-
Semichemical (neutral sulfite)	-	-

Source: U. S. Forest Service, 1962.

Tree mortality as a result of insects, disease, fire, and weather is estimated at 0.75 percent of sawtimber inventory (Choate, 1966). Close surveillance of possible sources of outbreaks resulting from blowdown, logging debris, and fire is needed. There is a need to develop select strains and species of trees at local nurseries that are resistant to disease and insects.

WATERSHED PROTECTION AND MANAGEMENT

Land treatment measures and programs for the protection and management of watershed areas and preservation of the resource base are needed throughout the basin. Principal management needs of watershed lands are deferred rotation grazing practices, proper logging practices, proper road construction, and erosion control measures. In conjunction with the above-mentioned practices, many areas are in need of measures such as brush control and revegetation to establish ground cover. Other measures such as gully plugs, debris basins, etc. are needed to protect and improve watershed conditions. Table VI-6, page VI-8, shows the estimated land treatment needs on watersheds in the basin.

FLOOD PREVENTION

Eighty-five floodwater retarding structures in 19 watersheds and about 50,000 feet of channel construction and modification are needed to protect existing and projected floodplain developments during the next 10 to 15 years.

Floodplain studies are needed to assist in planning residential and commercial expansions and should include depth and frequency of flooding along stream channels and in pond areas.

FLOOD INSURANCE

Many of the communities have flood problems, but flood protection measures could not be justified. These communities, if incorporated, can take advantage of flood insurance made possible by the Flood Disaster Protection Act of 1973. The communities that are not incorporated need to incorporate or ask the county, if eligible, to apply for flood insurance.

LAND USE PLANNING AND ZONING

The need for land use planning and zoning is evident when flood prevention and protection costs are related to the public funds spent annually for emergencies. Historically, as the public invests heavier for flood prevention and protection, the emergency expenditures continue to grow.

There is a need for counties to develop comprehensive land use planning and zoning ordinances which consider the soil, water table, soil drainage, slope of land, subsurface geology, and flood hazard. As large areas of land are being changed from agricultural to residential and commercial uses, studies are needed to determine the adaptability

of the soils to these new uses as well as the impact of such changes on the economic and social aspects of the basin. Seismic studies to estimate earthquake probability should be made in areas where they have a history of occurring.

TABLE VI-6. ESTIMATED LAND TREATMENT NEEDS IN THE UPPER RIO GRANDE BASIN, NEW MEXICO

Land Treatment Systems by Major Management Areas	Acres Needing Treatment
1. Grassland	
1.b. Snowpack Management	4,100
1.c. Range Management	4,957,800
2. Grazable Woodland	
2.a. Pinyon-Juniper Control	877,000
2.b. Ponderosa Pine, Pinyon-Juniper Management	2,409,100
3. Brushland	
3.a.1. Sagebrush Control	83,800
3.b.1. Sagebrush Management	116,000
3.a.2. Chapparal Control 1/	36,000
3.b.2. Chapparal Management	46,400
3.b.3. Creosotebush Management	103,000
3.a.4. Mesquite Control	75,000
3.a.5. Rabbitbrush Control	32,000
3.b.5. Rabbitbrush Management	33,000
3.a.b. Yucca Control	3,200
4. Forest Land	
4.a. Mixed Conifer Management	143,000
4.b. Ponderosa Pine Management	391,000
4.c. Aspen Management	36,000
5. Bottomland	
5.a. Phreatophyte Control	86,300
5.b. Bottomland Management	18,800
6. Cropland, Hayland, and Pastureland	
6.a.1. Drainage	37,900
6.a.2. Improved Irrigation Systems	152,900
6.b. Dryland Management	11,300
6.c. Abandoned Cropland Management	117,200
7. Management and Treatment of Critical Erosion Areas	2,357,600
TOTAL	12,128,400

1/ Chapparal is mountain brush and includes oak, mountain mahogany, etc.

LAND STABILIZATION

An area of about 4.8 million acres is classed in a critical erosion condition. Some of the measures mentioned under Watershed Protection and Management are applicable and needed in stabilizing critically eroding areas. Control of surface runoff, soil stabilization through structural measures, and land treatment is needed to help solve erosion problems and downstream salinity problems. If steps are not taken to correct the deterioration of land, it is estimated that about 8 million acres will be in a critical state of erosion by 2020. Soil stabilization is needed on many of the road cuts in the basin. Unpaved roads and trails need treatment over much of the basin.

Streambank erosion studies are needed on: Rio Salado, Rio Puerco, Rio San Jose, Jemez River, Galisteo Creek, Santa Fe River, Pojoaque River, Rio Chama, and the Rio Grande.

PHOTO VI-2. BRUSH CONTROL AND GRASS SEEDING ON NAMBE PUEBLO WITHIN UPPER RIO GRANDE BASIN.

DRAINAGE IMPROVEMENT

There is a need for a combination of watershed stabilization, elimination of some diversion dams, and channel improvements to lower the water table and reduce flooding on the Rio Chama below Abiquiu Dam. The Rio Grande in the vicinity of Espanola needs channelization to prevent flooding. Drainage systems to the river in the Lyden area and in certain areas between Otowi and San Marcial are needed to reduce floodwater ponding and to aid in lowering the high water table. Lining irrigation canals and laterals would decrease the amount of drainage needed. Adequate arroyo channels to the river are needed to protect some of the poorly drained areas from flood and sediment damage. Estimated total cost for drainage improvement is $947,400 (Table VI-8, page VI-15), of which $190,000 is needed on about 7,600 acres in the next 10 to 15 years.

WATER NEEDS

The need for water has been based on three levels of projections of population and economic conditions: (1) OBERS, (2) Modified OBERS, and (3) State.

PHOTO VI-3. CATCHMENT BASIN FOR LIVESTOCK WATER MAKES WATER AVAILABLE ON THE RANGE WHERE OTHERWISE WATER WOULD NOT BE ACCESSIBLE

Table VI-7 shows the availability of water for depletion and reflects the natural increase in depletion by phreatophytes; but does not take into account water salvage, water savings (due to increased efficiency of irrigation), or increased water yields from the watersheds. The effects of the San Juan-Chama Diversion Project are reflected in the water availability for 1980, 2000, and 2020. The City of Albuquerque has been allocated 48,200 acre-feet of the imported water, but all of this allocation may not be put to use by the city until after 2000; consequently, water surplus is shown in some of the projections. However, projected water requirements will exceed available supplies between 1985 and 1990 under the State and Modified OBERS projections and between 2000 and 2020 under the OBERS projections. When this occurs, water will have to be transferred from agriculture use in order for it to be put into non-agricultural uses.

TABLE VI-7. WATER REQUIREMENT, NEED AND SURPLUS FOR PRESENT AND FUTURE USES, UPPER RIO GRANDE BASIN, NEW MEXICO (ACRE-FEET PER YEAR)

	1970	1980	2000	2020
Water Available				
Rio Grande	347,900	439,300 1/	418,700	393,400
Estancia	33,800	61,800	80,000	73,100
TOTAL	381,700	501,100	498,700	466,500
Projected Requirements OBERS	381,700	394,100	451,400	590,100
Need	0	0	0	123,600
Surplus	0	107,000	47,300	0
Projected Requirements Modified OBERS	381,700	461,500	544,800	684,700
Need	0	0	46,100	218,200
Surplus	0	39,600	0	0
Projected Requirements State	381,700	493,100	643,800	918,800
Need	0	0	145,100	452,300
Surplus	0	8,000	0	0

1/ Includes the 100,000 acre-feet from San Juan-Chama Project and is assumed that this water can be used to supply projected needs.

Efficiently used rangeland requires adequate livestock watering facilities. Installation of stock ponds, wells, and pipelines for water distribution is needed to fulfill this requirement. Present water use related to livestock is about 8,000 acre-feet per year. Projected livestock water use will increase to about 9,200 acre-feet by 2020. Assuming the proposed rangeland treatment program is applied, livestock numbers should increase by about 40,000 animal units, and the water use would be about 9,650 acre-feet per year for the same time.

PHOTO VI-4. PERMANENT STRUCTURES OF THIS TYPE DECREASE MAINTENANCE COST, PROMOTE EFFICIENT TRANSPORTATION OF WATER, AND MINIMIZE LOSSES SCS PHOTO 12-P799-10

PHOTO VI-5. CANAL AND DITCH LINING DECREASE THE AMOUNT OF LAND FOR RIGHTS OF WAY, SEEPAGE LOSSES, GROWTH OF NON-BENEFICIAL PLANTS, IMPROVE WATER EFFICIENCIES AND ARE MORE SIGHTLY SCS PHOTO 12-P614-9

IRRIGATION

In 1969, irrigated lands were developed to the extent of the water supply available, except in some ground water areas. A major part of the farm land was irrigated with surface water; however, in some instances, surface supplies were augmented by ground water. Irrigation water delivery efficiencies ranged from about 30 to 50 percent, and farm efficiencies ranged from 35 to 60 percent.

A present need is to improve both delivery and on-farm irrigation efficiencies and increase productivity of the lands. In some tributary areas, if an economical irrigation enterprise is to develop, there is a need for regulation of streamflows to overcome late season water shortages. Adequate diversion dams, improved canal systems, improved water management, and improved farming practices are needed throughout the basin.

There is a need to use the existing water supply of the area by initiating water conservation practices on farm lands. There are about 152,900 acres of irrigated land with problems pertaining to management or application of water.

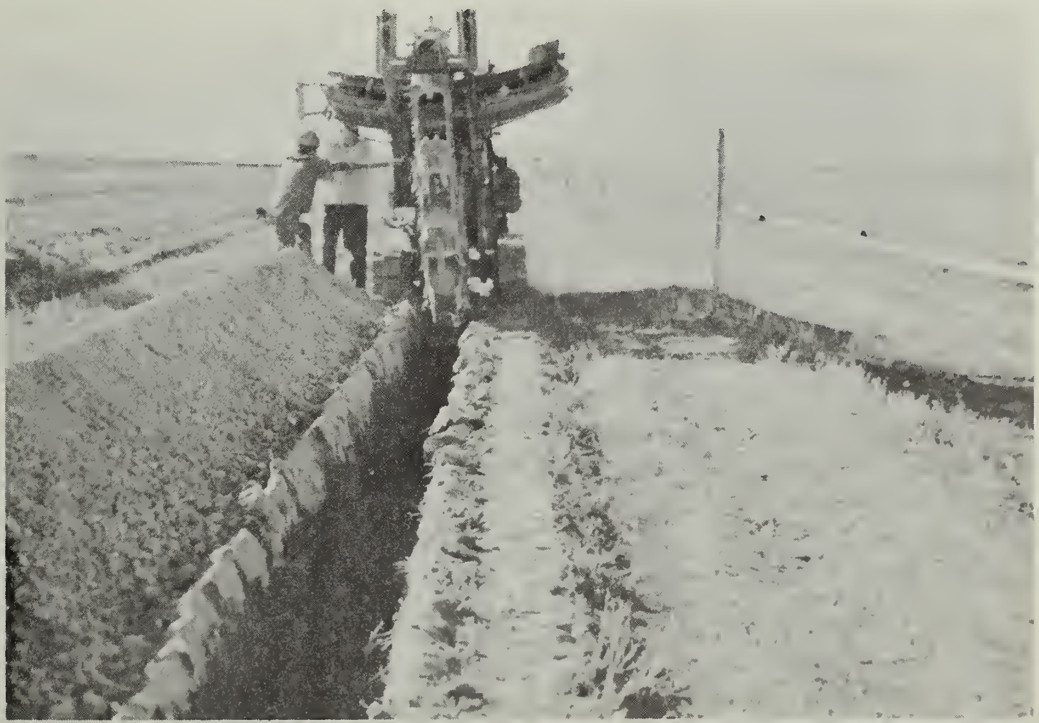


PHOTO VI-6. INSTALLATION OF IRRIGATION PIPELINE MAKES FOR EFFICIENT USE OF WATER. THIS TYPE OF INSTALLATION CONSERVES SOIL AND WATER - TORRANCE COUNTY, NEW MEXICO

PHOTO VI-7. WATER IN IRRIGATION FACILITIES HAS MULTIPLE PURPOSE USES

SCS PHOTO 12-P991-4

PHOTO VI-8. COMPARISON OF FLUMES, EAST RIO ARRIBA NATURAL RESOURCE CONSERVATION DISTRICT

The major need for additional water is to meet future projected crop irrigation requirements and regulation of streamflow on tributaries, recreation, fish and wildlife. Consolidation of irrigation systems and elimination of makeshift diversion dams and paralleling ditches would permit more efficient diversion and use of available water. Some of the measures needed are irrigation ditch lining and water control structures, adjusting length of irrigation runs, land leveling, and improved water application. These measures if applied on the 152,900 acres are estimated to cost $16,819,000 (see Table VI-8). Estimated application during the next 10 to 15 years based on past installation rates should be about $5,060,000.

TABLE VI-8. SUMMARY OF IRRIGATION AND DRAINAGE NEEDS AND COSTS FOR IMPROVING IRRIGATION EFFICIENCIES BY REACHES - UPPER RIO GRANDE BASIN, NEW MEXICO

Reach	Irrigation Area with Problems Acres 1/	Estimated Irrigation Development Cost ($'s) 2/	Acres to be Drained	Estimated Drainage Cost ($'s) 3/	Estimated Project Cost ($'s)
New Mexico-Colo. State Line to Embudo Stream Gage	23,728	2,610,100	1,920	48,000	2,658,100
Embudo Gage to Otowi Gage	33,705	3,707,600	5,230	130,800	3,838,400
Otowi Gage to San Felipe including Jemez	11,485	1,263,300	2,350	58,800	1,322,100
San Felipe to San Marcial	50,065	5,507,100	27,600	690,000	6,197,100
Rio Puerco	8,367	920,400	790	19,800	940,200
Estancia Closed Basin	25,550	2,810,500	-	-	2,810,500
TOTAL	152,900	16,819,000	37,890	947,400	17,766,400

1/ Area indicated in the 1969 New Mexico Conservation Needs Inventory.
2/ Unit cost approximately $60 per acre and $50 per acre for land improvements. Includes diversion dams, reorganization, consolidation, and canal lining with water control structures.
3/ Unit costs approximately $25 per acre.

PHOTO VI-9. TRANSPORTING IRRIGATION WATER ACROSS EXISTING ARROYO CHANNEL.

COMMUNITY WATER SUPPLY

There are 42 communities (as of 1966) that need water systems or expansion and improvement of existing systems, and 60 communities that need sewerage systems. Rural residents and communities without sewerage systems must rely on privies, cesspools, and septic tanks for disposal of home wastes.

The communities of Tres Piedras, Los Alamos, Acoma Pueblo, Tijeras, and Magdalena need detailed studies to determine the adequacy of ground water resources. There is a need for improving the quality of water supplies in some rural communities (see Table V-4, page V-19).

WILDFIRE

There is a need to implement the effective use of fire as a management tool and to identify those areas where the accumulation of fuels could be reduced by use of controlled burning. There is a need to determine how fire might be beneficially used to suppress inferior plants and increase the growth of desirable plants.

Advance planning for providing fire breaks in continuous fuel is needed to prevent possible conflagration. Preplanning fire strategy for high valued lands such as municipal watersheds, electronic sites, highly developed recreation sites, and residential areas is needed. The heat sensor is a device worth evaluating for early detection use. There is a constant need for highly mobile equipment and manpower if an emergency should arise.

FISH AND WILDLIFE

Fish and wildlife resources in the basin should be given adequate consideration in the formulation of all related resource planning. There will be continuing and expanding pressure to preserve and enhance those remaining habitats needed to supply the demand for hunting and fishing. Under the OBERS projections there will be an estimated demand for about 650,000 recreation days of hunting and 1,900,000 recreation days of fishing by 1980.

PHOTO VI-10. FISHING ENHANCES FAMILY RECREATION AT SANTA CRUZ RESERVOIR EAST OF ESPANOLA

Additional big game habitat needs to be provided, primarily through the coordination of range and timber management planning. Because of the limited amounts of fishing water in the basin it will be desirable to create permanent waters in all proposed impoundments. Many miles of existing streams are in need of fish habitat improvements to allow for the full utilization of their fish production potential.

Lakes and ponds need remedial management to control aquatic weeds and rough fish species. Streambank stabilization and erosion control is needed in some streams that are tributaries to lakes in order to reduce the silt load reaching the lakes. There is a need to develop, manage, and maintain a portion of the phreatophyte area for wildlife habitat and streambank protection. About one-third of the 1964 phreatophyte area would provide some of the needs for recreation.

Forest Service estimates of fish and wildlife needs are as follows:

1. Establish a water quality monitoring network to determine the effect various management practices have on the fish and wildlife habitat; and identify the key habitats for preservation of rare and endangered species of fish and wildlife.

2. There is a need to keep critical big game ranges under surveillance for shifts resulting from pressure exerted by other uses. Additional watering facilities are needed to disperse game over a wider area to relieve extremely localized overuse.

3. In the reseeding programs, construction of fences, water developments, etc., wildlife must get full recognition of their needs. This should include minimizing game barriers that may result from range improvements for livestock use.

OUTDOOR RECREATION

"Outdoor Recreation--New Mexico", the New Mexico Comprehensive Plan for Outdoor Recreation, states that the *"most urgent outdoor recreation need for New Mexicans is for recreation parks in urban areas and for natural scenic parks and recreation areas near cities"*. This is especially true of Albuquerque. At present it has a deficit of city parks. The Sandia and Manzano Mountains immediately east of the city provide an outlet for some of Albuquerque's picnic and other recreation needs.

The most sought after recreation experiences are those that have a special attraction such as streams, lakes, climatic relief, scenery, and open space. Overcrowded conditions necessitate a need to study and improvise methods to disperse users. Other needs include prevention of erosion and site deterioration resulting from heavy use. There is a need to analyze and improve existing facilities that limit use

PHOTO VI-11. HIGHWAY ROADSITE REST STOP NEAR TAOS, NEW MEXICO

SCS PHOTO 12-P591-5

PHOTO VI-12. OUTDOOR RECREATION FACILITIES, SANTA CLARA CANYON CAMPGROUND

SCS PHOTO 12-P533-11

resulting from inadequate parking, signing, access, etc. It is necessary to determine the carrying capacity of the resource in relation to the capabilities of the land base to withstand the impact. Roads need to be improved to provide access to the desirable recreation sites that are now inaccessible.

The 1960 outdoor recreation land and water surface requirements were estimated to be 389,500 acres increasing to about 1,500,000 acres by 2020. Present and future needs for land and water recreation are as follows: 177,000 acres in 1980; 498,600 acres in 2000; and 941,000 acres in 2020.

The state recreation plan lists agency responsibilities for providing outdoor recreation facilities and needs as follows:

Agency Responsibility	Area of Responsibility	Needs
City, county	Within 25 miles of cities	City and regional parks for play, picnics, camping, etc. for day-to-day use.
State	25-125 miles from cities	Develop new and improve existing state parks for week-end and holiday use, and provide for hunting and fishing demands.
Federal		Camp and picnic facilities and access roads for week-end and vacation use.

According to a recent study (ERS, 1967), there is a need for better and more campsites and motel rooms in the basin mountain areas for use during the summer months.

P O L L U T I O N

Conservation treatment is needed to reduce erosion and consequent pollution of the streams by sediment. This reduction in erosion would probably help in reducing the salt content in the Rio Grande. Designated areas for garbage and trash disposal, which do not contribute to water and air pollution, are needed. Community sewage systems are needed to prevent surface and ground water polluting. There is a need for better methods of controlling effluent from mining operations that may be accidentally dumped into streams. Studies are needed relative to the role of insecticides and commercial fertilizers as stream pollutants.

POWER SUPPLY

Electrical power is supplied to rural areas primarily by three electric cooperatives. The cooperatives purchase power from Plains Electric Generation and Transmission Company, Inc., Albuquerque. Sales purchased by two of the major cooperatives increased from 9,709,811 to 23,613,599 kilowatt hours from 1955 to 1963. Past trends by the power company and by REA (Rural Electric Association) were obtained from the Public Service Company of New Mexico for urban areas and cooperatives for rural areas. Based on past trends, electric power requirements were projected to 2020. These projections are shown in Table VI-9.

TABLE VI-9. ESTIMATED ELECTRIC POWER REQUIREMENTS - UPPER RIO GRANDE BASIN, NEW MEXICO

Year	Number of Meters		Average Annual Use per Meter (kwh)		Power Requirements kwh x 10^6		Total Power Requirements kwh x 10^6
	Urban	Rural	Urban	Rural	Urban	Rural	
1960 1/	106,000	30,000	10,000	5,000	1,060	150	1,210
1970 1/	140,700	40,000	15,600	7,400	2,200	300	2,490
1980 2/	190,000	49,000	20,500	9,600	3,900	470	4,370
2000 2/	300,000	56,300	25,200	14,100	7,560	800	8,350
2020 2/	449,400	80,400	27,500	18,600	12,360	1,500	13,854

1/ Obtained from record of Public Service Company of New Mexico and Cooperative Power Company.
2/ Projected by River Basin Field Party.

REFERENCES

Choate, Grover A., 1956 - New Mexico Forest Resources, Rocky Mountain Forest and Range Experiment and Intermountain Forest and Range Experiment Station, USFS Resource Bulletin, INT-5.

Economic Research Service, 1967 - Outdoor Recreation in North Central New Mexico, 1967. U. S. Department of Agriculture, Economic Research Service, August 1971, ERS 483.

Liefer, James A., 1970 - Attitudes Toward Land Ownership and Usage in North Central New Mexico, M. S. Thesis, NMSU, June 1970.

Marr, Eldon G., 1967 - "Agriculture in New Mexico", New Mexico Business, October 1967. Bureau of Business Research, University of New Mexico, Albuquerque, New Mexico.

U. S. Forest Service, 1962 - Pulp Manufacturing Information; Forest Products Laboratory, Leaflet WFPR-89.

CHAPTER VII

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

This chapter discusses existing projects and programs designed to solve some of the water and related land problems in the basin. Within the U. S. Department of Agriculture programs of the Soil Conservation Service, the Rural Electrification Administration, Agricultural Stabilization and Conservation Service, Farmers Home Administration, Economic Research Service, Agricultural Research Service, and Forest Service are discussed. A brief background is given for each along with some of their contributions in the basin.

Programs of the U. S. Army Corps of Engineers, the Bureau of Reclamation, Bureau of Land Management, Bureau of Indian Affairs, Fish and Wildlife Service, National Park Service, the Geological Survey, and Bureau of Outdoor Recreation are covered. Programs of New Mexico State Departments are also discussed.

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE (SCS)

The SCS was established by Public Law 46 in 1935. Among its goals, duties, and responsibilities was the charge to carry on the programs of the Soil Erosion Service.

The purpose of the SCS was to provide for the protection of land resources against erosion, the conservation of land resources, the control of floods, and to prevent impairment of reservoirs. In order to accomplish this purpose, the SCS function includes necessary investigations.

Presently, about 25 percent of the privately-owned and state-leased lands have been adequately treated with needed conservation measures. These measures include land treatment and management practices necessary for conservation of soil and water resources on rangeland and cropland. Soil surveys have been completed on about 37 percent of the area.

Since the establishment of the SCS, the Small Watershed Program (Public Law 566), the Resource Conservation and Development Program (Public Law 91-343), the Great Plains Conservation Program (Public Law 1021), and others have been enacted to enhance the application of conservation measures to carry out the intent of the original act.

Typical conservation practices installed in the basin with SCS technical assistance include: (1) brush control and range improvement; (2) conservation cropping systems; (3) irrigation system development and water management; (4) floodwater retarding and diversion structures; (5) woodland management; (6) proper grazing use of rangelands and grazable woodlands; and (7) other practices basic to and a necessary foundation for better utilization of soil and water resources. The SCS also participates in cooperative snow surveys with other federal and state agencies.

There is one flood prevention project (Prop Canyon and Tributaries) under Public Law 566, and there is one pilot project (Bernalillo and Tributaries) which have been completed. Two flood prevention projects have been authorized, and four are being planned under Public Law 566 as follows:

Sebastian Martin-Black Mesa - authorized
Corrales - authorized
Belen-Los Lunas - planning
Espanola-Rio Chama - planning
Sandia - planning
Santa Cruz - reopened for planning

There are three flood prevention projects completed under the Resource Conservation and Development Program (Las Cruces Arroyo, Medanales, and La Mesilla). These projects will provide protection to about 25 percent of the irrigated cropland and urban areas damaged from runoff from upstream watersheds. Many other projects for soil and water conservation have been completed under the RC&D program.

The Northern Rio Grande Resource Conservation and Development Program started action on land title transfers in 1966 (Project Measure #147), and the sponsors secured an $85,000 land title study (State of New Mexico, $15,000; Four Corners Regional Commission, $70,000). This led to a $795,000 survey and monumentation effort (1972) funded by matching funds of $265,000 each from the state, the Four Corners Regional Commission, and the Economic Development District.

PHOTO VII-1. A FAMILY OPERATION - PACKING INGREDIENTS FOR MEXICAN FOOD PRODUCTS INITIATED UNDER THE RC&D PROGRAM

RURAL ELECTRIFICATION ADMINISTRATION (REA)

The REA has a significant impact upon both farm and rural non-farm residents and their ability to utilize water and related resources more efficiently. Service is being provided to customers throughout the area upon request and as the need arises. To supply demands, the Jemez Mountains and Kit Carson Electric Cooperatives, Inc. have received approval for a substantial loan from the Rural Electrification Administration for construction of transmission lines and distribution lines to serve new customers and for other improvements to the systems. REA has loan resources for the development needs of cooperators. In 1970, about 300,000,000 kwh were being furnished to the rural areas.

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE (ASCS)

This agency administers the Rural Environmental Assistance Program. This program shares the cost of installing needed conservation practices that provide enduring benefits, significant pollution control, enhancement of the environment, and promotion of the conservation of soil and water resources. The program is available to individuals or groups of land operators. Pooling agreements and special projects permit groups of operators to share the application cost of conservation treatment with the government. Treatment that is cost-shared under this program is oriented toward the solution of community environmental problems.

One of the important programs in the basin has been a community ditch rehabilitation program carried out as a cooperative effort by REAP, New Mexico State Engineer, and local ditch organizations.

The Soil Conservation Service provides technical assistance to the Rural Environmental Assistance Program where needed to plan, design, and install conservation practices.

Other programs administered by ASCS include:

Set-Aside Programs - Under these programs farmers receive compensatory payments for devoting acreage to conservation use that is normally used for the production of wheat, feed grains, or cotton.

Cropland Adjustment Program - This program compensates farmers who enter contracts to convert cropland to grass, trees, or other non-agricultural uses for conservation purposes.

Price Support Program - Provides price support loans, purchases, and payments to maintain prices and income from wool, mohair, dairy products, grain, cotton, cottonseed, beans, and honey.

Rural Environmental Conservation Program - Authorized by the 1973 Farm Bill, provides cost-sharing programs for permanent type conservation practices installed on the land over a period of years, as agreed upon by the land user and USDA.

FARMERS HOME ADMINISTRATION (FHA)

This USDA lending agency provides credit and management aid for people in rural areas. Loan programs available to farmers or other rural residents who are unable to obtain adequate financing from private sources include:

1. Farm ownership loans.
2. Farm operating loans.
3. Housing loans.
4. Economic opportunity loans.
5. Soil and water conservation loans to individual operators.
6. Loans to rural groups for soil and water conservation and shifts in land use. This includes loans for irrigation system improvement and loans to grazing associations.
7. Water and sewerage facility loans and grants are available to municipalities, counties, or other subdivisions of government. Groups of farmers or urban dwellers who form associations for the purpose may also apply.
8. Watershed loans are made to local organizations to help finance projects that protect and develop land and water resources in small watersheds.

ECONOMIC RESEARCH SERVICE (ERS)

The ERS analyzes factors affecting farm production and their relationship to the environment, prices and income, and the outlook for various commodities. It studies production efficiency; marketing costs and potentials; rural development and natural resources; agricultural trade, production, and Government policies.

ERS performs planning and analysis functions in cooperation with other USDA agencies.

AGRICULTURAL RESEARCH SERVICE (ARS)

The ARS performs research in crop and livestock production, soil and water, and related areas. The ARS has collected data on an established experimental watershed (Cornfield Wash) in the basin, which has been and will continue to be helpful in determining runoff from storms.

Both ERS and ARS can provide information and analyses on a contract basis for basin problems.

PHOTO VII-2. TIMBER STAND IMPROVEMENT PROJECT - STATE AND PRIVATE FORESTRY

SCS PHOTO

FOREST SERVICE (FS)

Cooperative State-Federal Forestry Program - This program was made possible through several enabling federal legislations. The state has direct administration of the cooperative programs and provides on-the-ground services. Responsibility delegated to the FS, through the Secretary of Agriculture by the Congress, is for proper use of federal cooperative funds and counseling with the state in establishing and developing the protection and management of non-federal forest and certain non-forested watershed lands. New Mexico started its State Forestry organization in December 1957. Their programs include: (1) Cooperative Fire Control for state and private lands. About 9,250,000 acres are under protection in the basin; (2) Cooperative Forest Management - State Forester provides technical services to timberland owners in the management of forested areas. Assistance includes timber inventory, management plans, marking timber for harvesting and timber stand improvement, recreation development, tree planting for windbreaks, shelterbelts and forest plantings, wildlife management, and utilization and marketing of forest products. A total of 47 plans statewide is an increase of five times over the previous years; (3) Cooperative tree distribution - trees and tree seeds are available to private landowners at a nominal cost. The State Forester is distributing approximately 200,000 trees each year on a statewide basis. Los Alamos and Taos plantation and nursery projects have been established to determine survival problems of new plantations; and (4) Resource Conservation and Development Program (RC&D) - State assists local Steering or Council Committee in the field of forestry. Studies are in progress on stump harvest for removal of resin for possible naval store operations, research on harvesting systems, and use of sawmill waste and other waste for power production.

The New Mexico Department of State Forestry is headquartered at Santa Fe. Two of the five district offices are located in the basin - at Chama and Magdalena.

National Forest Development and Multiple Use Program - The Carson and Santa Fe Forests are ranked as the two highest average water producers among the national forest lands of the southwest. They produce an estimated average of 378,000 and 295,000 acre-feet of water, respectively (USFS MU Management Guide, 1967).

In watershed management activities the reconnaissance and comprehensive hydrologic survey is completed on 22 percent of the area; reconnaissance and standard soil survey is completed on 45 percent of the area; water use requirement and availability survey is 72 percent complete. Watershed restoration measures completed comprise about 15 percent of the Project Work Inventory. National forests contribute about 80 percent of the total volume of timber harvested annually. Cultural accomplishment for timber resources amounts to about 25 percent of the estimated annual needs. There are 914 permittees that own and

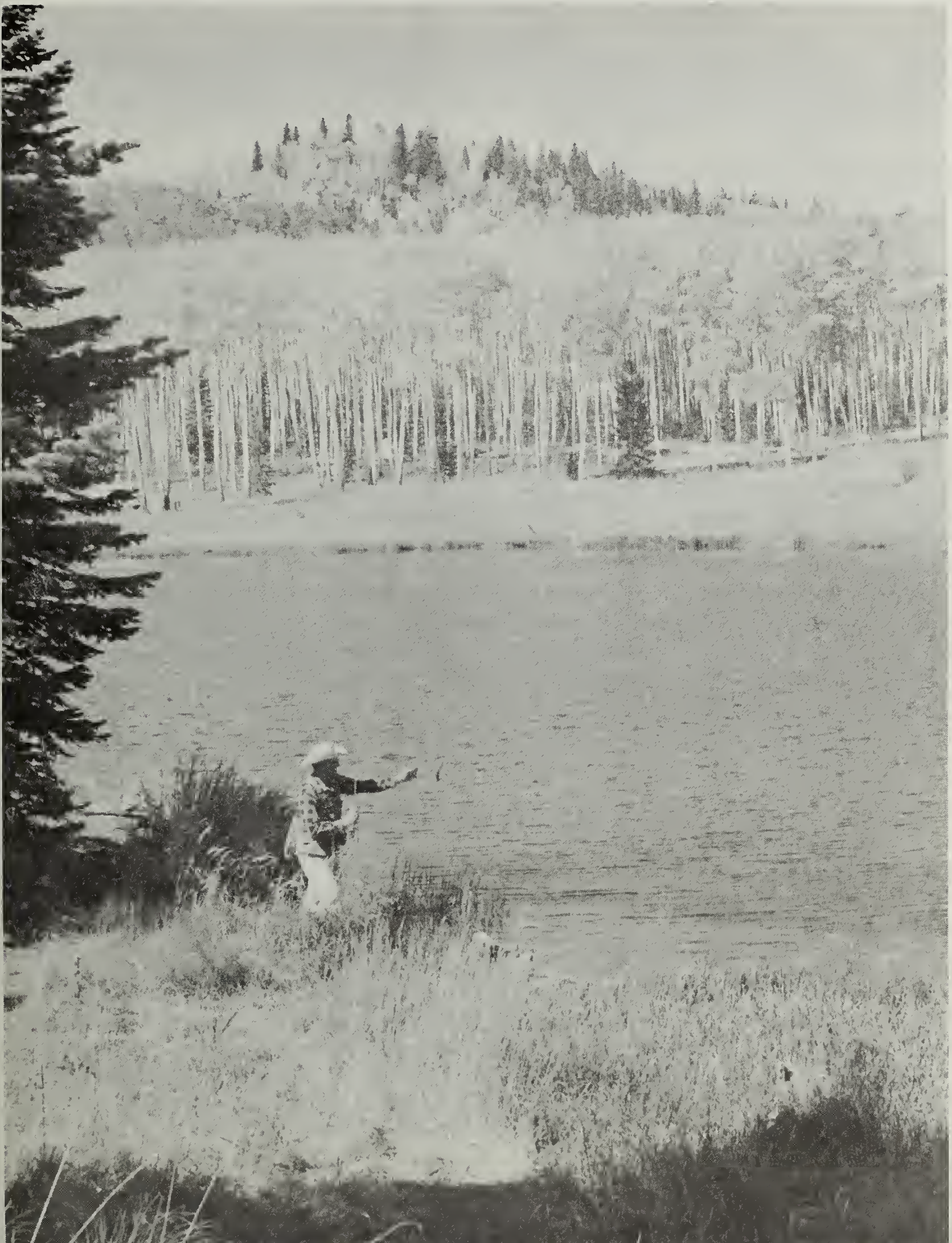


PHOTO VII-3. CANJILON LAKE, CARSON NATIONAL FOREST

US FOREST SERVICE PHOTO

graze 35,100 cattle and 40,200 head of sheep and goats on 310 allotments. Range management plans are implemented and used to retain and improve the forage resources.

There are about 100 recreation sites that provide 870 family units designed to handle 4,350 people at one time. These developed sites are in excess of 500 acres. Streams originating in the higher elevations provide approximately 800 miles for fishing. Also, there are about 500 acres of lake waters. Some 1,223 miles of trails meander through some of the most scenic areas. Five of the eight developed ski areas located in the state are in the Santa Fe and Carson National Forests.

Wildlife habitat management includes developing openings, food patches, watering facilities, and stream improvement for fisheries. A list is maintained of the rare and endangered fowl, fish, and animal species for special management considerations. Protection of resources, life, and property from wildfire is accomplished by fuel treatment and fire prevention activities. Included in the basin are 118,000 acres of wilderness areas managed for the preservation of land having wilderness characteristics.

The research center located at Albuquerque is one of three field units of the Forest Service Rocky Mountain Forest and Range Experimental Station. Forest Service scientists are conducting studies in reforestation, insects and disease control, watershed rehabilitation, and range and wildlife vegetation improvements.

U.S. DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

The Corps of Engineers water resources development program in the Upper Rio Grande Basin was initiated in 1942. As authorized by Section 4 of the 1941 Flood Control Act, a detailed investigation of all known problems began in cooperation with the Department of the Interior and other interested federal and state agencies. As a result, a comprehensive plan of improvement for the basin was developed, has been followed, and provides the following control: (See Table VII-1, page VII-9).

TABLE VII-1. CORPS OF ENGINEERS PROJECTS

Project	Area Controlled (sq. miles)	Total Storage Capacity (ac. ft.)	Sediment Capacity (ac. ft.)
Jemez Canyon Dam and Reservoir	1,034	113,900	40,900
Abiquiu Dam and Reservoir	2,147	1,223,100	77,000
Cochiti Dam and Reservoir	14,600	602,000	110,000
Galisteo Dam and Reservoir	596	89,800	10,200

The location and status of major Corps of Engineers projects in the basin are shown on Project Location (Other than USDA) Map (facing page VII-10).

Jemez Canyon Dam and Reservoir was the first project to be completed in the comprehensive plan. Jemez Canyon Dam is located on the Jemez River about two miles above its confluence with the Rio Grande near the town of Bernalillo, about 17 miles north of Albuquerque. The reservoir controls the runoff from a mountainous watershed area.

Abiquiu Dam and Reservoir is located about 45 miles northwest of Santa Fe on the Rio Chama, about 30 miles upstream from the confluence of the Rio Chama and Rio Grande. The reservoir regulates flood runoff from spring snow melt and rainfall from the mountainous Rio Chama Watershed. Sediment control is one of the authorized purposes of Abiquiu Reservoir, and a 4,000 acre-foot retention pool is maintained in the reservoir. The regulation of heavy runoff offers occasional opportunity for water-associated recreation.

Cochiti Dam and Reservoir was authorized by Public Law 645 and is under construction. It is located on the Rio Grande at the upper end of the Middle Valley where the river emerges from White Rock Canyon near the Cochiti Pueblo. The site is about 40 miles north of Albuquerque and about 22 miles southwest of Santa Fe. In addition to flood and sediment control, the reservoir will have a permanent pool of 50,000 acre-feet and a surface area of about 1,200 acres for fish, wildlife, and recreation.

Galisteo Dam and Reservoir is located on Galisteo Creek, which joins the Rio Grande about five miles downstream from the Cochiti Dam site. The dam has been completed, and the reservoir, when full, will extend upstream for a distance of about four miles to the vicinity of the village of Waldo. The entire capacity of the reservoir is allocated for flood and sediment control.

Albuquerque Diversion Channels Project - Flooding of low areas in the City of Albuquerque is caused by runoff from the drainage area east of the valley. There are no outlets across the valley floor to the river, and the floodwaters pond in the urban, suburban, and rural areas along the river. The Albuquerque Diversion Channels Project was authorized by the Flood Control Act of 1954.

By act of state legislature, the Albuquerque Metropolitan Arroyo Flood Control Authority was created to provide local sponsorship for the project. The North Channel was completed in 1968 and is about 10 miles long. The South Channel, about 6.3 miles long, was completed in late 1971. It is estimated that the project will reduce flood damages by $2.5 million annually.

Rio Grande Floodway was authorized by Flood Control Acts of 1948 and 1950 as a joint undertaking by the Corps of Engineers and the Bureau of Reclamation to provide flood protection and major drainage to the Espanola and middle valleys of the Upper Rio Grande Basin. Work apportioned to the Corps of Engineers consists of rehabilitation of the existing levee system and levee stabilization works where necessary throughout the valley. The work assigned to the Bureau of Reclamation consists of channel rectification and stabilization in the interest of major drainage and water salvage.

The Espanola Valley Unit of the floodway extends about 24 miles downstream from Velarde to the Otowi Bridge. About 17 miles of channel rectification has been completed through the Espanola Valley.

The Middle Rio Grande reach of the floodway will extend from Cochiti downstream to the upper limits of Elephant Butte Reservoir. The Albuquerque unit consists of a 20-mile reach in the vicinity of Albuquerque that falls within the Cochiti-Rio Puerco unit. In this reach a levee about 18 miles long was built along the east bank of the river to protect the principal business and industrial sections of the city and low-lying residential districts. In this same reach, another levee, nine miles long, was constructed on the west bank of the river to protect an urban and suburban area. The remainder of the Cochiti-Rio Puerco unit of the floodway consists of rebuilding approximately 125 miles of existing levees, channel clearing and straightening, and installation of jetties.

Planning the San Acacia-Bosque del Apache Unit of the floodway has been deferred pending the results of feasibility investigations of flood and sediment control dams on the Rio Puerco and Rio Salado. The Bureau of Reclamation has completed a drainage and water salvage program, consisting of a low-flow channel and floodway clearing project extending from Elephant Butte Reservoir upstream past the City of Socorro.

COMPLETED WATER DEVELOPMENT PROJECTS

2. Costilla Lake
4. Cabresto Lake
11. Heron Reservoir
11a. Azotea Tunnel
12. El Vado Reservoir
14. Abiquiu Reservoir
20. Santa Cruz Reservoir
21. Rio Grande Floodway (Middle)
24. McClure Reservoir
25. Nichols Reservoir
26. Galisteo Reservoir
27. San Gregorio Reservoir
29. Fenton Lake
31. Jemez Reservoir
33. North Albuquerque Flood Diversion
33a. South Albuquerque Floodwater Diversion
34. Bluewater Lake
35. San Mateo Reservoir
36. La Joya Wildlife Refuge
37. Socorro Flood Diversion
38. Bosque del Apache Wildlife Refuge
39. Elephant Butte Reservoir

PROJECTS UNDER CONSTRUCTION

23 Cochiti Reservoir

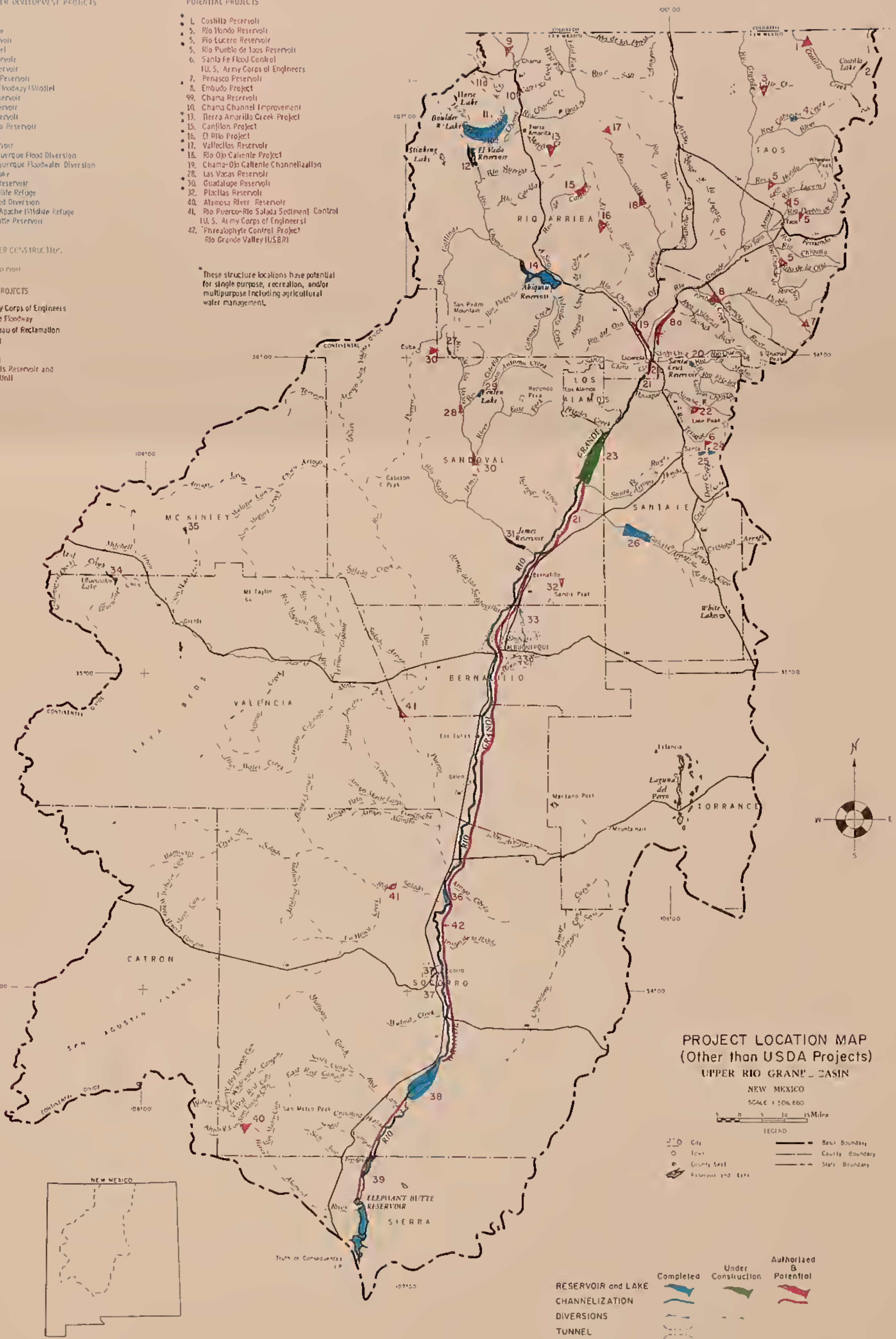
AUTHORIZED PROJECTS

U. S. Army Corps of Engineers
21a. Rio Grande Floodway
U. S. Bureau of Reclamation
* 3. Cerro Unit
* 5. Taos Unit
* 8a. Llano Unit
22. Nambe Falls Reservoir and Pojoaque Unit

POTENTIAL PROJECTS

* 1. Costilla Reservoir
* 5. Rio Hondo Reservoir
* 5. Rio Lucero Reservoir
* 5. Rio Pueblo de Taos Reservoir
6. Santa Fe Flood Control (U. S. Army Corps of Engineers)
7. Penasco Reservoir
* 8. Embudo Project
9. Chama Reservoir
10. Chama Channel Improvement
* 13. Tierra Amarilla Creek Project
* 15. Canjilon Project
* 16. El Rito Project
* 17. Vallecitos Reservoir
* 18. Rio Ojo Caliente Project
19. Chama-Ojo Caliente Channelization
28. Las Vacas Reservoir
* 30. Guadalupe Reservoir
* 32. Placitas Reservoir
40. Alamosa River Reservoir
41. Rio Puerco-Rio Salado Sediment Control (U. S. Army Corps of Engineers)
42. Phreatophyte Control Project Rio Grande Valley (USBR)

* These structure locations have potential for single purpose, recreation, and/or multipurpose including agricultural water management.



U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO

NOVEMBER 4-R-34449

Socorro Diversion Channel Project - consists of a combination of channels and levees for the diversion of floodwaters into the Rio Grande. This combination of diversions and levees provides a high degree of flood protection to the City of Socorro.

U.S. DEPARTMENT OF INTERIOR

BUREAU OF RECLAMATION

Elephant Butte Dam was constructed in 1916 by the U. S. Bureau of Reclamation. The stored water is used for irrigation in New Mexico and Texas with incidental power production.

The Bureau of Reclamation currently operates and maintains the works of the rehabilitated Middle Rio Grande Conservancy District.

San Juan-Chama Project - was authorized by Public Law 87-483 and is a participating project of the Upper Colorado River Storage Project. It will divert an average of 110,000 acre-feet of water annually from the upper tributaries of the San Juan River through the Continental Divide for utilization in the Rio Grande Basin in New Mexico.

Imported waters will be used to serve the City of Albuquerque with an additional 48,200 acre-feet of municipal water. The project will also provide 20,900 acre-feet of supplemental irrigation water for 81,610 acres of land in the Middle Rio Grande Conservancy District; 5,000 acre-feet for recreation in Cochiti Reservoir; 27,700 acre-feet for tributary irrigation units; and the remainder will be consumed by evaporation at Heron Reservoir.

Diversion facilities located in the San Juan River Basin above Navajo Reservoir consist of three diversion dams, two siphons, and three tunnels to bring San Juan River Basin water through the Continental Divide. The imported water will be regulated in Heron Reservoir on Willow Creek, a tributary of Rio Chama.

Tributary Irrigation Units

Cerro Unit - is north of Red River, 27 miles north of Taos. The plan now being investigated would provide an improved water supply from ground water to lands in the Cerro area. This unit would provide supplemental irrigation water for about 11,820 acres of irrigated land.

Taos Unit - is located near the town of Taos. The plan being investigated would provide an improved water supply to both Indian and non-Indian lands in the area. Indian Camp reservoir would

provide 12,000 acre-feet of storage on Rio Grande del Rancho for irrigation and recreation. Ground water would be used to supplement the remaining lands in the unit. The plan would provide an adequate water supply for a total of 20,550 acres of arable land.

Llano Unit - consists of the Velarde Diversion Dam on the Rio Grande about one mile above Velarde and the Llano Canal, paralleling the Rio Grande above Espanola. An adequate supply of water will be provided for 4,669 acres of land, of which 1,922 acres are Indian lands. The project will extend across the Santa Cruz River and serve a part of the Santa Cruz Irrigation District lands.

Pojoaque Unit - is located about 16 miles north of the City of Santa Fe. The construction of Nambe Falls Dam and Reservoir will regulate the flows of Nambe Creek to provide an adequate supply of water for 2,768 acres of land. The reservoir will have a capacity of 2,000 acre-feet.

Rio Grande Water Salvage Project. In cooperation with the New Mexico Interstate Stream Commission the U. S. Bureau of Reclamation (USBR) operates and maintains low flow channel floodways above Elephant Butte Reservoir and other river works.

BUREAU OF LAND MANAGEMENT

The Bureau of Land Management (BLM) has jurisdiction over mineral, range, recreation, forest, wildlife, and water resources on 14 percent of the land (2,744,800 acres) in the basin. Most of the land is primarily suitable for wildlife and livestock grazing, and a little is forest. Grazing privileges are granted by licenses and permits, which specify numbers, classes, and season of use. Range improvement projects such as brush control, erosion control structures, stock tanks, and fences are involved in range use administration. Effects on wildlife habitat are also considered in range development. Recreational development programs are under way in cooperation with the State Park Commission.

BLM is charged with making examinations to determine the mineral character of the land, validity of mining claims, land suitability leading to classification, appraisal of mineral materials, and land classified for title transfer. They also handle the mineral leasing for oil and gas, potassium, phosphate, coal, sodium, and sulphur.

The BLM receives all applications for use of the national land reserve and its resources. It maintains all basic land records from early territorial days. It has custody of Spanish land grant records from early 1600, on which most of the land title of New Mexico is based. They perform official cadastral surveys to determine property boundaries.

BUREAU OF INDIAN AFFAIRS

The Bureau of Indian Affairs administers programs in land resource use and management in the fields of agricultural education, soil conservation, irrigation, range management, outdoor recreation and wildlife, and forest management. These services are rendered to 17 pueblos and the Jicarilla and Navajo Tribes. The combined Indian lands constitute 11 percent (2,053,900 acres) of the basin.

The objectives of these programs are to furnish technical advice to the Commissioner of Indian Affairs for use in performing the Bureau's trust responsibilities to Indians in the development and conservation of their soil, plant, and water resources; also, to assist the Indians through technically coordinated programs to assure their responsibilities in the conservation, use, development, management, and educational processes as they pertain to their natural resources.

FISH AND WILDLIFE SERVICE

The Fish and Wildlife Service cooperates with other federal and state agencies to develop the full value of the basin's fish and wildlife. Their fish hatcheries supply some of the stock for public, state, and Indian fishing waters within the basin. Bosque del Apache Refuge contains over 56,000 acres of river bottom and hillside land. It was established in 1939 for protection and feeding of wintering migratory waterfowl. The refuge is also used to collect management data pertaining to migratory bird species, depredation control, and permit-management activities. Principal migratory bird species include mourning doves, band-tailed pigeons, sandhill cranes, ducks, geese, ospreys, and eagles.

Predatory animal and rodent control is conducted under a cooperative program to protect livestock, game, crops, forage, and irrigation structures. It also curtails incidents of wild-animal-borne disease to which humans or valuable animals may be susceptible. Under cooperative agreement with New Mexico Department of Game and Fish, federal agents also enforce state as well as federal game laws.

NATIONAL PARK SERVICE

Significant segments of prehistoric, historic, and scenic areas are preserved under the National Park System for enjoyment and inspiration of the people. Bandelier National Monument encompasses more than 46 square miles and is administered by the National Park Service. The monument contains the ruins of prehistoric Indian homes of the later Pueblo period. It was named in honor of Adolph F. A. Bandelier, Swiss-American scholar who extensively surveyed the prehistoric ruins in the region. The National Park Service also renders assistance on historic, archeological, historical and natural landmarks with federal, state, and Indian programs.

U. S. GEOLOGICAL SURVEY (USGS)

The USGS cooperates with local, state, federal agencies, and private organizations in conducting stream-gaging programs to determine water quantity and quality. At the present time the USGS operates about 104 gaging stations in the basin, which include nine reservoirs and 27 canals, ditches, drains, etc. Water quality stations include nine chemical, 14 temperature, and 21 sediment. Also, 41 crest-stage and miscellaneous measurement stations are operated. In addition, the USGS cooperates in studies of underground water supplies and detailed topographic mapping. USGS in cooperation with the New Mexico State Engineer performs ground water studies to obtain water level and quality data. About 85 percent of the basin has been mapped.

STATE DEPARTMENTS

STATE DEPARTMENT OF GAME AND FISH & STATE PARKS AND RECREATION COMMISSION

These are the principal state agencies that develop and maintain facilities for recreation, fish, and wildlife purposes. In the basin there are 10 state parks and monuments with a total area of about 68,100 acres, of which 22,950 acres are water.

Three state parks--Bluewater, Elephant Butte, and El Vado Lakes--encompassing leases of 45,190 acres of land and 22,950 acres of water, are developed for water-based recreation. Major municipalities also operate and maintain parks, swimming pools, and other public recreation facilities. Most of the acreage in state parks is operated under lease agreement.

About 57,820 acres of land are owned and managed by the New Mexico Department of Game and Fish for the improvement of big game, fish, upland birds, and waterfowl conditions. In addition, over 90,000 acres of privately-owned land are leased by the department for big game purposes. Over a million acres of state trust lands are leased for hunting purposes.

ENVIRONMENTAL IMPROVEMENT AGENCY

The Environmental Improvement Agency (EIA) was organized in 1971 as the agency within the Department of Health and Social Services responsible for water and land environmental programs such as domestic water supplies, water quality, vector control, and solid waste management.

In addition to a state office located in Santa Fe, the basin has two regional offices--one in Santa Fe and one in Albuquerque. Each regional office administers the agency's program with the aid of a professional environmentalist assigned to each county.

The goal of the EIA is "to insure an environment that: (1) in the greatest possible measure, will confer optimum health, safety, comfort, and economic and social well-being on its inhabitants; (2) will protect this generation, as well as those yet unborn, from health threats posed by the environment; (3) and will maximize the economic and cultural benefits of a healthy people."

FOREST CONSERVATION COMMISSION

This commission governs the Department of State Forestry. New Mexico State Forestry is to provide for the practice of forestry, according to standards that will protect the timber and timber products and also protect the watersheds of the state. They are authorized to enter into agreements with federal or private agencies. The New Mexico State Forestry has about 9.2 million acres under protection within the basin.

CONSERVANCY, IRRIGATION, OR OTHER DISTRICTS

MIDDLE RIO GRANDE CONSERVANCY DISTRICT

The Middle Rio Grande Conservancy District is a political sub-division of the State of New Mexico. It was organized in 1925 to rehabilitate and operate an irrigation water delivery and drainage system in the Middle Rio Grande Valley. The district operates one storage reservoir, four diversion dams, five drainage wells, 780 miles of canals and laterals, 393 miles of open drains, 250 miles of maintained levees, and 186 miles of river channel.

Irrigation water for the district is diverted from the river at four main points. In the district there are 121,680 acres of land with water rights. About 40,000 acres are classed as "6W" (unsuitable for sustained irrigation because of frequent flooding or high water table). The system is operated and maintained by the USBR.

El Vado Dam and Reservoir, located on the Rio Chama, was completed in 1935 by the Middle Rio Grande Conservancy District. The reservoir is operated by the district to store and regulate water for irrigation. When full, it has a surface area of about 3,500 acres and a capacity of about 200,000 acre-feet. El Vado Reservoir is used extensively for fishing and boating.

SANTA CRUZ IRRIGATION DISTRICT

The Santa Cruz Irrigation District, formed in November 1925, completed construction of the Santa Cruz Dam and Reservoir in February 1929. Although planned to have a capacity of about 6,700 acre-feet, the capacity as constructed is about 5,300 acre-feet. A sediment survey conducted in 1956 showed that the capacity had been reduced to 3,758 acre-feet. About 3,800 acres of land is irrigated from the Santa Cruz Reservoir. The reservoir usually fills to capacity each spring. In addition to water storage for irrigation, the reservoir provides fishing, boating, and other recreational activities.

POJOAQUE VALLEY IRRIGATION DISTRICT

The Pojoaque Valley Irrigation District has been organized to contract with the Bureau of Reclamation for the Pojoaque tributary unit irrigation project. The repayment contract between the district and the Bureau has been signed but has not implemented pending negotiations with the Pueblo Indians.

An agreement between the three pueblos (Nambe, Pojoaque, and San Ildefonso) is being negotiated for the diversion of the operation and maintenance costs and division of the waters between district lands and the Indian pueblos.

Negotiations are underway between the Bureau of Reclamation and the Nambe Indians for right-of-way for construction of Nambe Falls Dam and Reservoir and the administration of the recreation facilities at Nambe Falls Reservoir.

ONATE CONSERVANCY DISTRICT

The Onate Conservancy District has been organized to contract with the Bureau of Reclamation for the Llano tributary unit irrigation project. The district includes the City of Espanola and a portion of the Santa Cruz Irrigation District.

A repayment contract has been signed by the Bureau of Reclamation and the district, and construction can start when negotiations for division of operation and maintenance costs has been completed between the district and the San Juan and Santa Clara Indian pueblos. The Indian pueblo lands included in the project are not included in the conservancy district. The Santa Cruz Irrigation District has petitioned to join the Onate Conservancy District and have all the lands of the Santa Cruz Irrigation District included.

The Santa Cruz Irrigation District has also requested the Interstate Stream Commission to allocate additional San Juan-Chama water to this project so that additional water can be furnished for the rest of the Santa Cruz Irrigation District lands.

Some of the presently irrigated lands between Velarde and Espanola are not included in the project plan as they have not requested such inclusion; however, the Velarde Diversion Dam is designed with sufficient capacity to serve these lands should they desire to consolidate and receive water from this one diversion in the future.

BLUEWATER TOLTEC IRRIGATION DISTRICT

The Bluewater Toltec Irrigation District made application to appropriate water from Bluewater Creek for irrigation in 1923. Streamflows were to be regulated in the Bluewater Reservoir, which would have 92,100 acre-feet of storage. In 1927, the application was amended reducing the storage to 52,000 acre-feet. In June 1948, the State Game and Fish Commission of New Mexico contracted with the district for a minimum pool of 3,500 acre-feet in the reservoir for fish culture and recreation. The district has water rights of about 16,500 acre-feet per year to irrigate about 5,500 acres of land in the Bluewater-Milan-Grants area. At present, a portion of these rights is being utilized by the uranium industry in the district.

OTHER RESOURCE PROGRAMS

RESERVOIRS

There are several small regulating reservoirs that serve private and Indian lands. An example is the San Mateo Dam and Reservoir, located on San Mateo Creek about one mile east of the village of San Mateo in north central Valencia County. The dam was constructed in 1934 as a Federal Emergency Relief Administration Project with a reservoir capacity of about 50 acre-feet. In 1954 needed repairs and an enlarged emergency spillway were completed by the state and local water users.

NATURAL RESOURCE CONSERVATION DISTRICTS

Natural Resource Conservation Districts are formed by locally organized groups of landowners who operate under state law to identify and combat problems involving soil and water. These districts with assistance from the Soil Conservation Service and other federal and state agencies are an effective force in fighting water and soil waste. Districts in the Upper Rio Grande Basin area include: Upper Chama, East Rio Arriba, Taos, Santa Fe-Pojoaque, Sandoval, Cuba, Jemez, Central Rio Grande, Salado, Sandoval, Sierra, Cuba, Socorro, East Valencia, McKinley, and Lava.

COMMUNITY DITCH SYSTEMS

Community ditch systems are surface irrigation systems owned by more than two parties, and when properly organized, are recognized as political subdivisions of the state. These systems are commonly referred to as "acequias". There are about 600 such systems operating in the basin.

PUBLIC ASSISTANCE PROGRAMS

Public welfare programs aid in training welfare recipients. Two federal programs designed to combat "hard core" unemployment are the Area Redevelopment Act (ARA) and the Manpower Development and Training Act (MDTA). Both give the New Mexico Employment Service the responsibility of identifying occupational training needs and the selection of trainees. The choice of training sites and the actual training are functions of the State Department of Education.

New Mexico counties that have been designated as economically depressed and all Indian reservations and pueblos are eligible for assistance under "ARA". Four "ARA" training sessions have been completed--one in 1963 and three in 1964, covering courses in handicraft work, agricultural skills, metals, and electronics.

Vocational training programs of the Northern New Mexico State School at El Rito, New Mexico include clerk-stenography, nurse's aide, farm machinery operation, cosmetology, business occupations, barbering, drafting, auto repair, building trades, welding, home economics, and agriculture (Employment Security Commission, 1965). Recent state legislation authorized improvement of training facilities at the school.

FOUR CORNERS ECONOMIC DEVELOPMENT REGION

The Four Corners Economic Development Region is a state-federal partnership set up in 1966 to promote economic development in 92 counties of Utah, Arizona, Colorado, and New Mexico. Some of the purposes of the commission are to initiate and coordinate overall economic development programs, perform faster surveys and studies, promote increased private and public investment in the area, assist in state and federal planning, and advise and assist the Secretary of Commerce in the initiation and coordination of economic development districts. All counties of the basin are within the New Mexico portion of the Commission boundaries.

AREA PLANNING ORGANIZATIONS

Within each State Planning and Development District in New Mexico is an area planning organization which functions as the regional association of local governments in the district. Some are called Councils of Government and others are referred to as Economic Development

Districts. All have similar functions. Each serves as a clearinghouse under federal authority of the Office of Management and Budget - Circular A-95. Most proposed projects involving federal expenditures are reviewed by the clearinghouse for consistency with on-going programs. Other functions involve regional, area-wide, and local planning efforts designed to support local decisions and to provide a framework for development activities.

Organizations represented in the basin are:

Middle Rio Grande Council of Governments -
Counties: Bernalillo, Sandoval, Torrance, Valencia.

North Central New Mexico Economic Development District -
Counties: Rio Arriba, Taos, Santa Fe, Mora, San Miguel.

McKinley Area Council of Governments -
County: McKinley.

Southwestern New Mexico Council of Governments -
County: Catron.

Rio Grande Council of Governments -
Counties: Sierra, Socorro.

REFERENCES

Employment Security Commission, 1965 - Economic Base Report, Smaller Communities Program, Rio Arriba County, New Mexico, April 1965, Employment Security Commission, New Mexico, State Employment Service.

Forest Service Handbook, 1967 - Multiple Use Management Guide, Southwest Region, USDA.

CHAPTER VIII

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

This chapter describes some of the potential water and land resource developments in the area relative to satisfying the problems and needs described in Chapters IV, V, and VI. Some of the possibilities expressed here are not presently economically feasible or socially desirable. However, as future social and economic changes occur, these possibilities may become a reality. Waters of the Rio Grande Basin are fully appropriated, and the effects of any new depletions would have to be offset by a transfer of water rights or with imported water.

FLOOD PROTECTION

WATERSHED PROJECTS

There are 19 upstream watershed projects for flood protection that are needed, feasible, and should be installed during the next 10 to 15 years. Included in these potential projects are 85 floodwater retarding structures and about 50,000 feet of channel construction and improvement. The retarding structures would be single-purpose for flood prevention. Installation of these projects would provide flood protection to 41,800 acres of highly developed land. All of the retarding structures are located on rangeland and will have minimal detrimental effects on the environment. Land for these measures should be available at a minimal cost. Most of the channels are in connection with the retarding structures, and where possible, are aligned with existing channels. About two-thirds of the channels needed would utilize irrigation canals and drainage ditches to carry the principal spillway discharges into the river. The Middle Rio Grande Conservancy District has easements for existing facilities and would, without any extra cost to them, grant easement for this purpose.

There are several areas along streams where channel improvements and levees can alleviate flooding of bottomland development. Part of the flooding problems now existing along the Rio Grande will be lessened when authorized works are completed by the Corps of Engineers and the Bureau of Reclamation. Channel modification on the Rio Chama below Abiquiu, about three miles on the Santa Cruz River at Riverside, two miles on Pojoaque River, and one mile on the Rio San Jose at Grants and Milan would alleviate flooding in these areas. Rights-of-way and access will have to be acquired to accomplish needed channel works. The channel on the Rio San Jose could be realigned, and the local people have agreed that the land rights involved can be obtained.

FLOOD INSURANCE

The Flood Disaster Protection Act of 1973 makes it possible for about 37 communities and Indian pueblos to obtain flood insurance. The insurance is provided by the Flood Insurance Administration of the Housing and Urban Development Department. To qualify for flood insurance, the communities must be incorporated. Five counties are qualified to receive flood insurance countywide--they are Bernalillo, Santa Fe, Los Alamos, McKinley, and Valencia counties.

LAND USE PLANNING AND ZONING

Cities and selected counties are authorized by the State Legislature to establish zoning regulations. The entire basin is in need of comprehensive land use planning. Floodplains should be clearly identified on

maps. Standards for residential and commercial development of floodplains should be drawn up. There are many areas that can be developed for residential and commercial uses and would be relatively free of problems relating to soils, drainage, high water table, and flooding.

IMPOUNDMENTS

MULTIPLE-PURPOSE

The U. S. Bureau of Reclamation has investigated 11 potential reservoir sites. These reservoirs would have a total surface area of about 3,000 acres, and water depletion would be about 28,000 acre-feet per year. The reservoir sites are:

- Amalia Dam
- Amador Dam
- Aqua Dam
- Cecelia Dam
- Coyote Dam
- El Rito Dam
- Guadalupe Dam
- Indian Camp Dam
- Nos-chee Dam
- Rodarte Dam
- Nambe Falls

SINGLE-PURPOSE

Reconnaissance investigations by the River Basin Field Party were made on 19 potential reservoir sites for recreation. From surface examination, it appears that they are suitable for dam and reservoir projects. Each would require further study, including water supply, water rights, site geology, and operating conditions that might be imposed by the Rio Grande Compact. Table VIII-1 shows details of these impoundments.

TABLE VIII-1. POTENTIAL SINGLE-PURPOSE RECREATION, FISH, AND WILDLIFE RESERVOIR SITES

Name	Surface Area (Acres)	Depletion (Ac. Ft.)
Beaver Creek Dam	300	550
Laguna Largo	50	96
Lucero Lake	50	104
Gavalian Creek Dam	150	310
Placer Creek Dam	16	43
Tusas Creek Dam	50	120
Rio Pueblo de Taos Dam	40	93
San Lorenzo Spring Dam	15	23
Rio de los Vacas Dam	20	30
Abiquiu Creek Dam	10	28
Nutrias Creek Dam	280	720
Rio Villecitos	240	360
Rio Chamita Dam	200	250
Truchas Dam	30	70
Rio del Oso Dam	15	40
Placitas Dam	30	103
Alamosa River Dam	70	310
Fort Hall Dam	30	128
Juan Tabo Dam	30	107
TOTAL	1,626	3,485

Note: Areas and depletions are estimates. It is estimated these structures would cost $4,750,000.

L A N D   T R E A T M E N T

Resource management and land treatment systems (see descriptions in Appendix I, pages AI-6 through AI-9) can be used to produce more forage and timber, increase water yields, and reduce erosion and sediment accumulations.

SNOW PACK MANAGEMENT

Snow fences can be erected for the purpose of accumulating snow packs on high mountain meadows and alpine slopes. The deep drifts retard evaporation and increase water yield for downstream use. It is estimated that about 4,100 acres of mountain meadows and alpine slopes have a potential for snow pack treatment and would increase water yield by about 700 acre-feet annually.

GRASSLAND MANAGEMENT

Range management practices have a potential for increasing forage and employment, and decreasing sediment damage and nutrient losses. The average range site is in fair condition. About 4,957,800 acres of rangeland have a potential of increasing forage by 248,000 tons a year, decreasing sediment yield by 205 acre-feet per year, and decreasing soil nutrient loss by $1,268,000 per year. Erosion control measures are needed on about half of this area to obtain these results.

FOREST LAND MANAGEMENT

This treatment includes spruce-fir-mixed conifer, ponderosa pine, and aspen timber types. In these areas the majority of the commercial timber is produced. It is estimated that 45 percent of the commercial timber area is old growth. Old growth is highly susceptible to insect, disease, and wind damage. There is a potential for restocking 94,860 acres of non-stocked areas to meet future demands.

Timber management and harvest, if designed for water augmentation, has a potential to increase water yield (on site) by about 46,100 acre-feet per year, increase employment, decrease sediment yield, and decrease soil nutrient loss by $140,900 per year. About 570,000 acres have a potential for this type of treatment.

WOODLAND MANAGEMENT

There is a potential for pinyon-juniper control and ponderosa pine, pinyon-juniper management on about 3.2 million acres, which in most cases are considered useable as rangeland. This treatment will have the following effects: about 21,900 acre-feet increase of water yield; 160 acre-feet reduction of sediment; $984,700 reduction in soil nutrient losses; and increase forage production of about 165,000 tons.

BRUSHLAND MANAGEMENT

The area with potential to respond to this treatment is about 528,400 acres. Brushland areas consist of sagebrush, chapparal, creosote, mesquite, rabbitbrush, and four-wing saltbush. Potentials from treatment of these areas would be about 48 acre-feet sediment reductions; $273,300 of reduction in soil nutrient losses; and 52,400 tons increase in forage production.

TABLE VIII-2. ESTIMATED LAND TREATMENT POTENTIALS IN THE UPPER RIO GRANDE BASIN, NEW MEXICO

Land Treatment Systems* by Major Management Areas	Acres with Potential to Respond to Needed Treatment
1. Grassland	
1.b. Snowpack Management	4,100
1.c. Range Management	4,957,800
2. Woodland	
2.a. Pinyon-Juniper Control	877,000
2.b. Ponderosa pine, Pinyon-Juniper Management	2,409,100
3. Brushland	
3.a.1. Sagebrush Control	83,800
3.b.1. Sagebrush Management	116,000
3.a.2. Chapparal Control	36,000
3.b.2. Chapparal Management	46,400
3.b.3. Creosotebush Management	103,000
3.a.4. Mesquite Bush Control	75,000
3.a.5. Rabbitbrush Control	32,000
3.b.5. Rabbitbrush Management	33,000
3.a.b. Yucca Control	3,200
4. Forest Land	
4.a. Spruce-Fir-Mixed Conifer Management	143,000
4.b. Ponderosa Pine Management	391,000
4.c. Aspen Management	36,000
5. Bottomland	
5.a. Phreatophyte Control	86,300
5.b. Bottomland Management	18,800
6. Cropland, Hayland, and Pastureland	
6.a.1. Drainage	37,900
6.a.2. Improved Irrigation Systems	152,900
6.b. Dryland Management	11,300
6.c. Abandoned Cropland Management	117,200
7. Management and Treatment of Critical Erosion Areas	2,357,600
TOTAL	12,128,400

*Land treatment systems are defined in the Appendix on pages A-1-6 through A-1-9.

BOTTOMLAND MANAGEMENT

It is estimated that about 111,500 acres of bottomland will be occupied by water-loving type plants (phreatophytes) by 2020. In 1960, phreatophytes covered an area of about 74,500 acres. The dense stand in much of that area curtailed use of the area.

It would be neither wise, technically sound, nor is it recommended to remove all phreatophytes. However, it is estimated that by the year 2020 this type of vegetation will be depleting 191,500 acre-feet of water.

TABLE VIII-3. ANALYSIS OF THE EFFECTS ON STREAMFLOW DEPLETIONS BY PHREATOPHYTES

Time Frame	Total Area (Acres) 1/	Expanded Area (Acres)	Consumptive Use: Total (Ac.Ft.) 2/	Consumptive Use: Potential Increase (Ac.Ft.)	Probable Depletion Effect on Streamflow (Ac.Ft.) 3/
1970	74,500		256,280		
1980	84,500	10,000	290,680	34,400	145,000
2000	96,500	22,000	331,960	75,700	165,600
2020	111,500	37,000	383,560	127,400	191,500

1/ Based on USBR studies on the Rio Grande from Abiquiu Dam down to Elephant Butte Reservoir headwaters in 1960 plus Upper Rio Grande and tributaries, estimated from aerial photographs and field reconnaissances made by River Basin Field Party projected to 2020 (100 percent density).
2/ Based on an average consumptive use of 3.44 feet per year (USBR study).
3/ Assuming about one-half of the water consumed by phreatophytes could be salvaged for other uses.

Phreatophyte management programs, if undertaken, should be done with a complete awareness of the trade-offs involved--comparing water increases with such values as (a) beauty; (b) recreation; (c) study and education; (d) wildlife habitat; (e) rare and endangered plant and/or animal communities; and, (f) production of honey.

Table VIII-3 indicates the estimated increase of phreatophytic growth in the basin if no control programs are installed. It shows the result on depletions of water due to increased area coverage and density by time frame.

MANAGEMENT AND TREATMENT OF CRITICAL EROSION AREAS

There are about 2,357,600 acres of critically eroded land that, if treated, has a potential to decrease sediment production by 446 acre-feet, reduce soil nutrient loss by $913,200, and increase forage production by 59,000 tons.

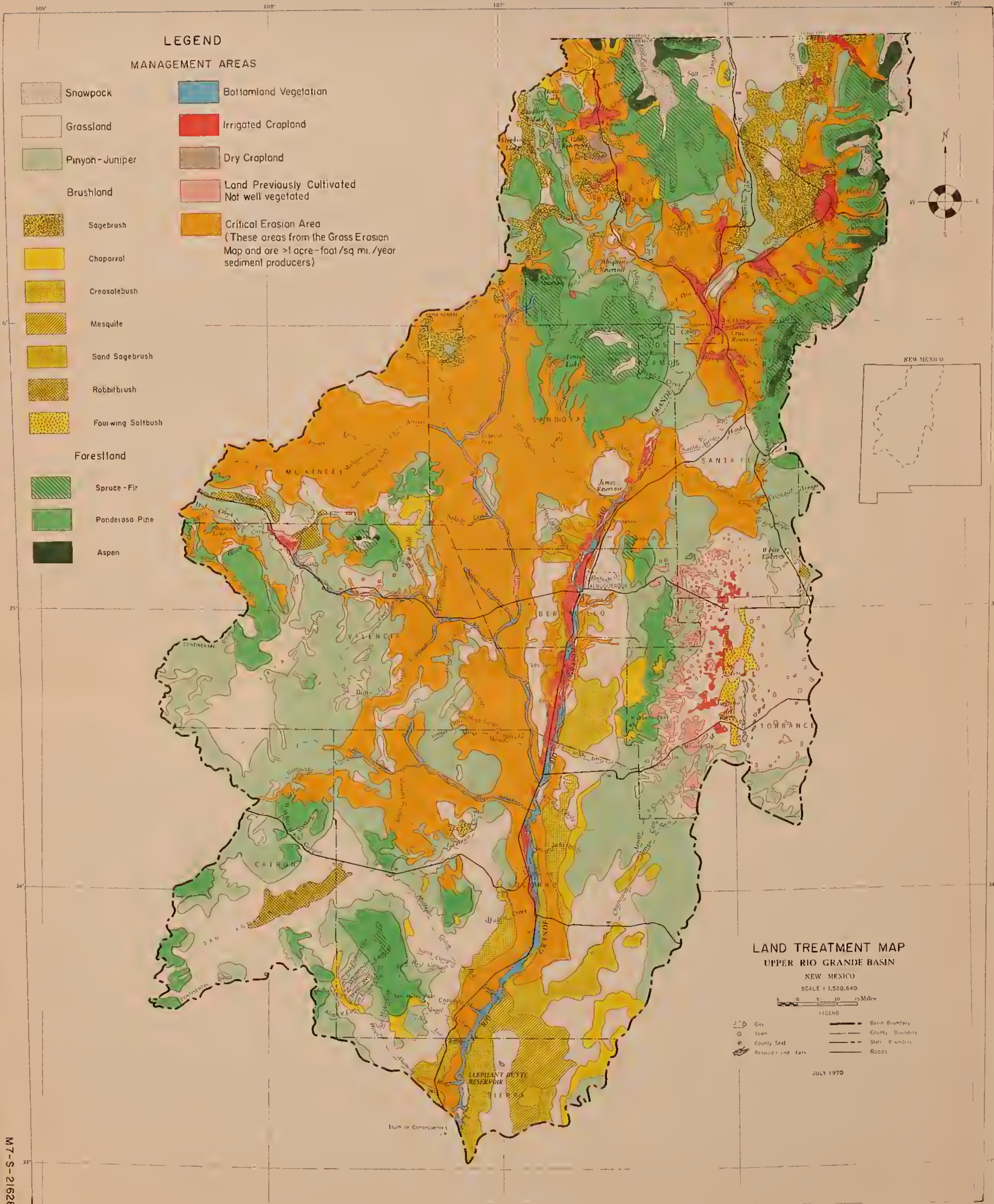

LEGEND
MANAGEMENT AREAS
Snowpack
Grassland
Pinyon-Juniper
Brushland
Sagebrush
Chaparral
Creosotebush
Mesquite
Sand Sagebrush
Rabbitbrush
Fourwing Saltbush
Forestland
Spruce-Fir
Ponderosa Pine
Aspen
Bottomland Vegetation
Irrigated Cropland
Dry Cropland
Land Previously Cultivated
Not well vegetated
Critical Erosion Area
(These areas from the Gross Erosion Map and are >1 acre-foot/sq. mi./year sediment producers)
LAND TREATMENT MAP
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
JULY 1970
NEW MEXICO
McKINLEY
SANDOVAL
SANTA FE
LOS ALAMOS
BERNALILLO
VALENCIA
TORRANCE
CATRON
SOCORRO
SIERRA
ALBUQUERQUE
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
RIO GRANDE

PHOTO VIII-1. PHREATOPHYTES (SALTCEDAR) ENCROACHMENT IN RIVER BOTTOM ALONG THE CHAMA RIVER

PHOTO VIII-2. NET WIRE DIVERSION - EROSION CONTROL ON RIO PUERCO DRAINAGE

TABLE VIII-4. SIGNIFICANCE OF IRRIGATION EFFICIENCIES ON ALL LANDS EXCEPT TOPOGRAPHICALLY CLOSED BASINS - UPPER RIO GRANDE BASIN, NEW MEXICO

Project Effi-ciency (%) 1/	Diversion Requirement (Ac.Ft.)	Difference in Diversion Requirement & C. I. R. (Ac.Ft.) 2/	Accumulative: Decrease in Losses 3/ (Ac.Ft.)	Estimated Decrease in Depletions 4/ (Ac.Ft.)	Average Annual Savings in 1,000 of Dollars			
					6/ $35 per Ac.Ft.	5/ $40 per Ac.Ft.	5/ $250 per Ac.Ft.	5/ $3,000 per Ac.Ft.
40	735,000	441,000	-	-				
45	653,300	359,300	81,700	12,300	430	492	3,075	36,900
50	588,000	294,000	147,000	22,000	770	880	5,500	66,000
55	534,500	240,500	200,500	30,100	1,053	1,204	7,525	90,300
60	490,000	196,000	245,000	36,800	1,288	1,472	9,200	110,400
65	452,300	158,300	282,700	42,400	1,484	1,696	10,600	127,200

1/ Efficiency based on diversion requirement to supply the CIR for 196,000 acres of irrigated land.
2/ (C.I.R.) Consumptive Irrigation Requirement = 1.5 feet/acre x 196,000 = 294,000 acre-feet (1980).
3/ Assuming present project efficiencies of 40 percent.
4/ Assuming 15 percent of the difference between water diverted and the C.I.R. is non-beneficially depleted.
5/ "Value of Water in Alternative Uses", Nathaniel Wollman.
6/ Estimated value of water in northern portion of Rio Grande, based on USBR data by River Basin Staff.

CROPLAND, HAYLAND, AND PASTURELAND MANAGEMENT

Improved irrigation systems and improved application efficiencies on about 196,000 acres of irrigated cropland will save about 42,400 acre-feet of water annually.

There are 117,200 acres of abandoned cropland which if treated will decrease sediment production by about four acre-feet, decrease soil nutrient losses of about $21,700, and increase forage production about 58,600 tons per year.

WATER DEVELOPMENTS

Water is available from surface runoff and underground water storage. Pumping from the ground water storage in the Rio Grande trough has been determined to directly affect the flow in the river. This is not true in the Estancia Basin where a substantial amount of ground water development has taken place.

Surface water in the basin is fully appropriated and ground water in the Rio Grande trough, because of its relationship with the surface waters, is subject to the rules and regulations of the State Engineer governing its appropriation and use.

The estimated water available for beneficial uses is as follows: 1980 - 497,900; 2000 - 495,500; 2020 - 463,300 acre-feet. The projected water requirements for the three years are shown in Table VI-7, page VI-11.

All projections show a need for more water before 2020. There are several ways deficits might be decreased if all that may become feasible is done locally to conserve the existing supply and to increase water yields from the watersheds. Improved irrigation efficiencies, increased yield from watersheds, and decreased non-beneficial use are ways that would help supply the water needed. It is estimated that by increasing the efficiency of delivery and application of irrigation water, depletions could be reduced about 42,400 acre-feet annually (Table VIII-5 page VIII-10). By 2020, there would be a potential for reclaiming about 191,500 acre-feet annually from phreatophytic vegetation and increasing water yields about 95,300 acre-feet through watershed management and treatment measures (Table VIII-5). Also shown in the table is a potential for reducing evaporation from open water and sand bars by 100,000 acre-feet. The total maximum potential by year 2020 of increased water yield and water savings is estimated to be about 429,200 acre-feet per year. This would increase the water available for beneficial depletions to about 791,000 acre-feet per year, which includes 100,000 acre-feet of San Juan-Chama diversion.

TABLE VIII-5. SUMMARY OF POTENTIAL FOR SAVING AND INCREASING WATER YIELD, UPPER RIO GRANDE BASIN, NEW MEXICO

	Treatable Area (Acres)	Increased Water Yield (Ac.Ft.)	Water Savings (Ac.Ft.)	Total (Ac.Ft.)
Mixed conifers and aspen	443,500	37,000 1/4/	-	37,000
Ponderosa pine	386,400	16,100 1/	-	16,100
Pinyon-Juniper	4,510,500	35,300 1/	-	35,300
Brush	1,644,000	6,900 1/	-	6,900
Phreatophytes	111,500 3/	127,800 2/	63,700	191,500
Evaporation (open water surfaces)	70,000	-	100,000	100,000
Irrigation efficiency	196,000	-	42,400	42,400
TOTAL		223,100	206,100	429,200

1/ Based on experimental data from watersheds by Forest Service adjusted to condition in Upper Rio Grande Basin.
2/ Based on data from U.S. Bureau of Reclamation study in basin, and one-half the water depleted can be salvaged.
3/ Projected area in phreatophytes without control by 2020.
4/ Assuming 443,500 acres or about one-half of the area in this cover type can be treated. Cutting would be effective in increasing water yield for 20 years and on the average about 35 square miles per year would be treated.

The potential for ground water development in the basin is quite varied. There are large areas in the basin with little or no ground water development potential, while other areas, such as valley alluvium along the Rio Grande, have potential for high production wells. In most instances, new uses of ground water can only be developed in the Rio Grande through retirement of existing surface water rights. Any water well development within a declared basin must comply with the state laws for appropriation of public waters.

Potential for ground water development for domestic use in Acoma Pueblo, Los Alamos, Magdalena, Tijeras, and Tres Piedras will be determined if and when detailed ground water studies are made for these areas. Available information indicates there is an adequate ground water supply for other communities with populations of 100 or more. In many of these communities additional and/or deeper wells will be needed to develop the potential of the ground water in the area.

Twenty-nine thermal water sources (anomalies, springs, and wells) have been identified in the basin that have water temperatures exceeding 90 degrees F. (see Chapter III). These hot water and steam sources

are virtually untapped except for two spas that were operated profitably prior to the advent of "miracle" drugs. There may be a potential for the development of these heat sources. Some examples are:

Heat--heating homes, businesses, public buildings, and greenhouses; drying processes (drying chile and other crops) or drying ores or other earth products; operating refrigeration units for cooling.

Hot water--revival of spas into recreation complexes with baths and heated swimming pools.

Energy--development of steam-electric plants to help meet the power needs of the state.

AGRICULTURAL PRODUCTION

RANGELAND

About 70 million pounds (live weight) of red meat is produced and maintained on the rangeland. With the recommended programs it is estimated that rangeland production can be increased to about 92 million pounds.

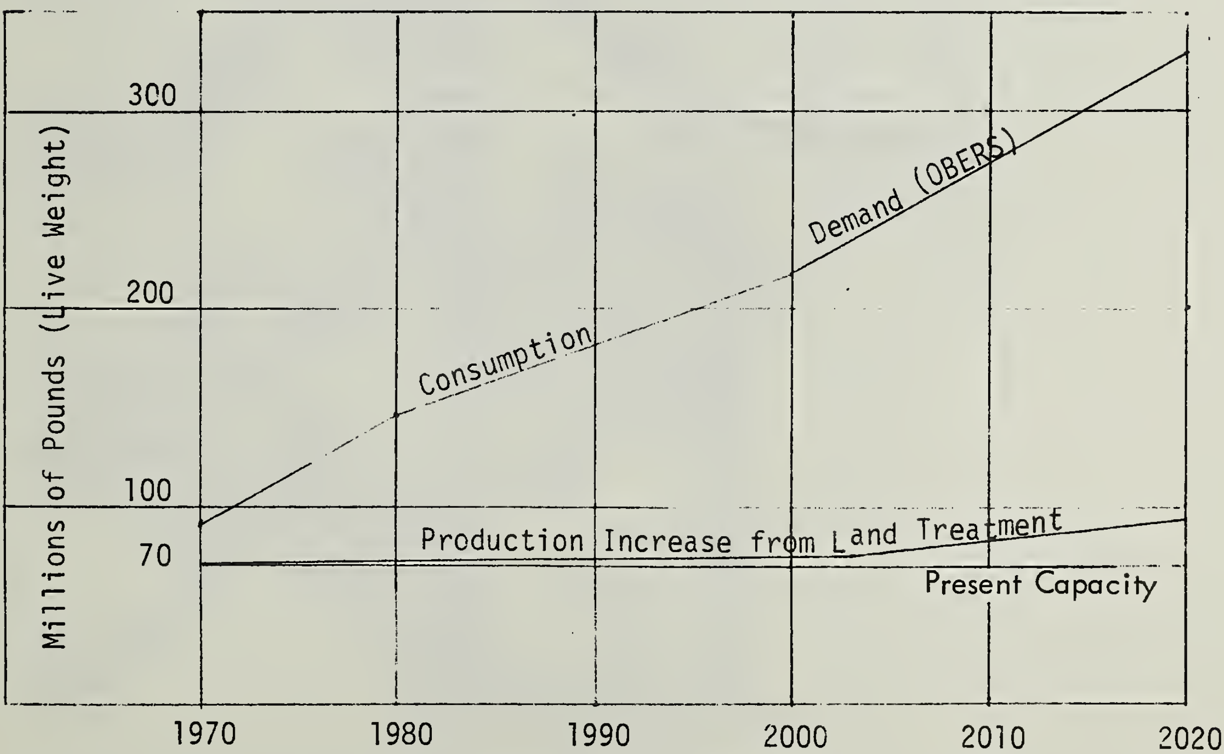


FIGURE VIII-1. POTENTIAL BASIN PRODUCTION OF RED MEAT ON RANGELAND AND FUTURE CONSUMPTION (CONSUMPTION IS BASED ON NATION'S PER CAPITA CONSUMPTION AND OBERS POPULATION PROJECTIONS).

by 2020, or an increase of about 22 million pounds. This potential production of red meat can be met and still maintain the wildlife population. Figure VIII-1, page VIII-11, shows potential production and future consumption of red meat.

Forage production on the range can be increased by about 19 percent with land treatment and management programs. Figure VIII-2 shows the present and potential production of forage to 2020.

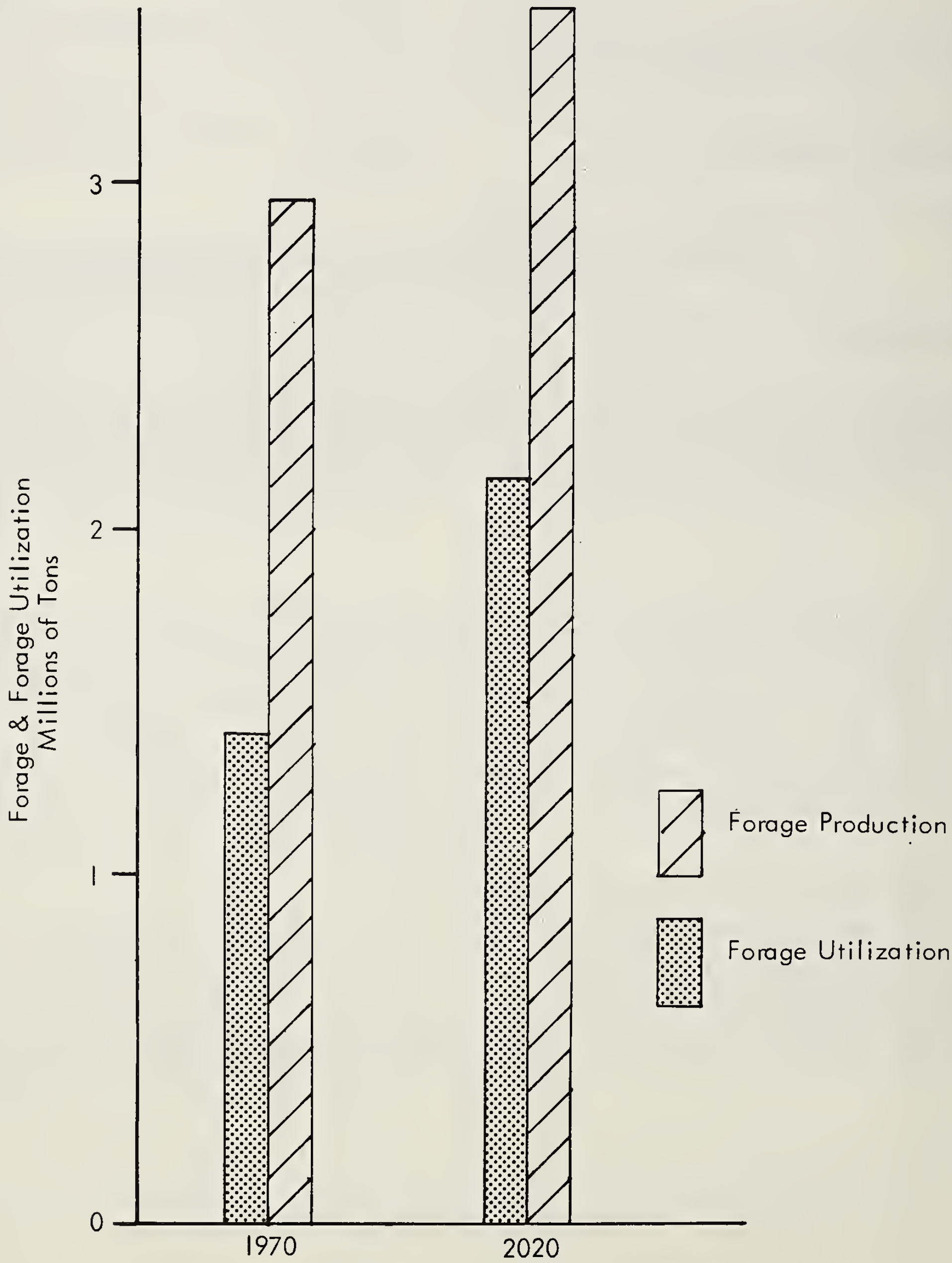
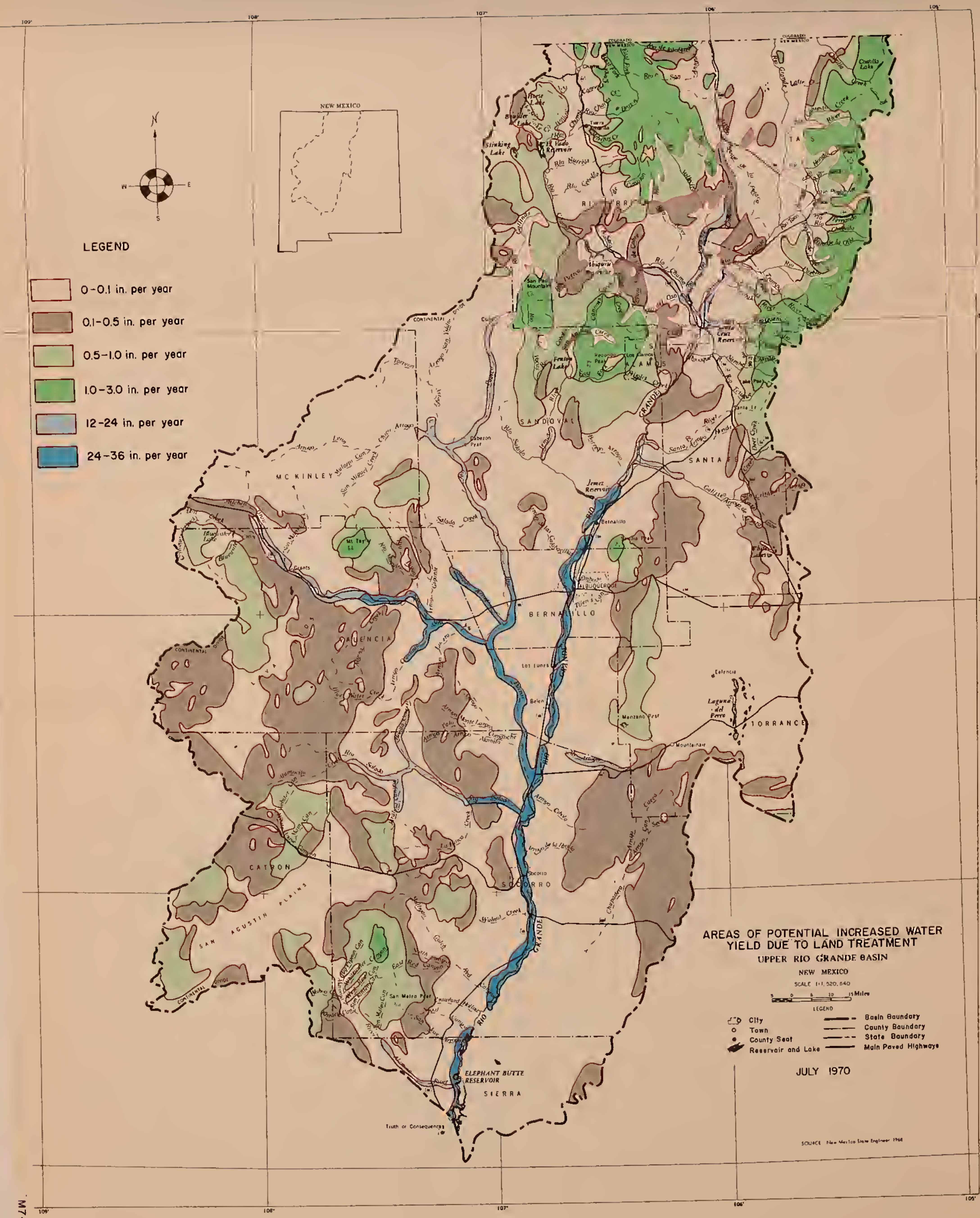


FIGURE VIII-2. POTENTIAL FORAGE YIELD AND UTILIZATION OF RANGELAND, UPPER RIO GRANDE BASIN, NEW MEXICO


NEW MEXICO
LEGEND
0-0.1 in. per year
0.1-0.5 in. per year
0.5-1.0 in. per year
1.0-3.0 in. per year
12-24 in. per year
24-36 in. per year
AREAS OF POTENTIAL INCREASED WATER YIELD DUE TO LAND TREATMENT
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
LEGEND
City
Town
County Seat
Reservoir and Lake
Basin Boundary
County Boundary
State Boundary
Main Paved Highways
JULY 1970
ELEPHANT BUTTE RESERVOIR
SIERRA
SOCORRO
CATRON
VALENCIA
BERNALILLO
TORRANCE
SANDOVAL
SANTA FE
MC KINLEY
SAN AGUSTIN PLAINS
RIO GRANDE
Albuquerque
Truth or Consequences

IRRIGATED LAND

Production on irrigated land is expected to increase by about 13 percent by the year 2020 because of changes in cropping systems, improvement in crop varieties, and increased use of fertilizers. Additional potential production on irrigated land would result from installation of needed drainage and improved irrigation systems.

If irrigated land presently producing feed crops were utilized for fattening beef, OBERS projected demand would be exceeded by about 10 million pounds by 1980, nine million pounds in 2000, and five million pounds in 2020.

The presently irrigated land cannot produce the livestock products consumed in the basin. However, land suitable for irrigation (5,159,000 acres) would more than meet the demand for producing livestock products if water were available for irrigation.

F O R E S T   R E S O U R C E

The estimated annual allowable cut of 160 million board feet for the basin is 20 million board feet below OBERS projection for 1970. The 1980 projection for the basin is nearly twice the present estimated allowable cut. A significant contributor of timber is the national forest. Its allowable cut is 103 million board feet, which represents 64 percent of the estimated allowable cut for the basin.

To achieve the projected volumes for the future would require the ultimate in forest management practices. These include optimum stocking, successful reforestation, thinning, and obtaining a greater degree of utilization.

A potential use of the forest resource exists in papermaking, particle board, charcoal, and veneer. It is estimated that there are 8.5 million cords of pulp material. The available supply is capable of supporting a 300 to 500 tons-per-day plant (Pulp and Papermaking Opportunities in Northern New Mexico). The logging residues, the unused supply of roundwood, and low quality trees are adaptable for pulping. If chipping sawmills and logging residues were found profitable, it is estimated that an additional 45 percent of the volume of the tree could be recovered as compared to about 22 percent when only lumber is produced (Landt and Woodfin). Secondary supplemental sources are dead and cull trees, aspen (other than pole timber), and pinyon-pine. Utilization of this type will favor advance timber management.

The materials used for particle board are the coarse residue and shaving not now being used for pulp chips. It is estimated that nearly 40 percent of the gross supply for particle board in New Mexico is in

the basin. This amounts to approximately 120,000 dry tons annually. This could supply three, 100-ton capacity plants and possibly five plants if roundwood materials were incorporated (NMSU Agricultural Experiment Station Bulletin No. 569, 1970).

Studies have indicated the technical feasibility of producing products from low grade and low value timber. Overlaid siding, laminated beams, and laminated flooring can be produced from knotty material through selective cutting, masking, and preassembly methods.

OUTDOOR RECREATION DEVELOPMENT

The basin has a great recreation potential, especially in the northern mountains.

A National Forest Recreation Survey in collaboration with the Bureau of Outdoor Recreation has designated more than 600 picnic and campground sites. New trails for hikers and nature lovers could be developed. About 360 miles of the proposed Continental Divide Trail lies along the western side and about 260 miles of the proposed trail's "East Leg" lies along the "eastern side" of the basin (Bureau of Outdoor Recreation, 1966). There is a potential for developing private picnic and camping areas near Albuquerque.

The projected need for ski areas is not great up to 1980. There are at least three potential ski areas in the basin that should be studied for feasibility (Skiing Trends in the West, USFS):

Mount Taylor--15 miles NE Grants on Grants Canyon Road--200 acres, 1,840 ft. vert. rise.

Mount Wheeler--6 miles S. Red River on State Highway 38--600 acres, 3,000 ft. vert. rise.

Santa Clara Canyon--15 miles SE Espanola on State Highway 30--640 acres, 1,800 ft. vert. rise.

In addition to the 56 miles of the wild and scenic Rio Grande from the Colorado border to State Highway 96, there are about 200 miles of free-flowing streams in the basin that deserve study for possible recognition and inclusion in the National Wild and Scenic Rivers System.

Nineteen potential sites for single-purpose recreation reservoirs are located in the upper part of the basin with an estimated surface area of about 1,630 acres. In addition, 27 potential sites for small reservoirs have been defined by the National Forest Recreation Survey in cooperation with the New Mexico Department of Game and Fish.

FISH AND WILDLIFE DEVELOPMENTS

This basin contains some of New Mexico's finest fish and wildlife habitat, and as a result, provides residents and visitors with hunting, fishing, and wildlife observing opportunities that are without comparison.

There are many opportunities for enhancing this important resource. They include:

1) Vegetative land treatment will improve habitat for wildlife by providing greater food supplies and more protective cover. Larger populations can be supported.

2) Floodwater protection structures will protect wildlife habitat below the structure sites.

3) Land treatment designed for erosion control and sediment retention structures will reduce the amount of sediment reaching streams and lakes containing fish. Spawning areas and food supplies will be protected.

WATER QUALITY

Improvement in water quality can be partially accomplished by treatment of critical sediment-producing areas, improving irrigation system efficiencies, controlling phreatophytic growth, and increasing the water yield. Table VIII-5, page VIII-10, indicates the estimated increase of water that could occur from specific land treatment systems.

There is a potential through the State Environmental Improvement Agency and federal programs of assistance to provide sewerage and solid waste management systems in many communities. There are adequate land areas containing suitable soils where garbage and trash disposal facilities can be located. These would not contribute to the pollution of surface and subsurface waters.

ELECTRIC POWER

There is a potential for increasing electrical power through use of thermal, nuclear, and hydro resources. However, most of the needed electrical power will probably be imported from outside the basin.

REFERENCES

Bureau of Outdoor Recreation, 1966 - New Mexico Comprehensive Plan for Outdoor Recreation in North Central New Mexico, 1967, 1975, and 1980

Landt, E. F. and Woodfin, R. O., Jr. - "Sawmill and Logging Residue from Ponderosa Pine Trees in the Black Hills", Rocky Mountain Forest and Range Experiment Station, USFS, Research Note RM-23

NMSU Agricultural Experiment Station Bulletin No. 569, 1970 - Economic Feasibility of a Particle Board Industry in New Mexico

United States Bureau of Reclamation, 1968 - San Juan-Chama Project

____, 1957 - San Juan-Chama Project

____, 1962 - Reconnaissance on Embudo Creek

United States Forest Service - Skiing Trends in the West

USDA, FS in cooperation with Bureau of Business Research, UNM - "Pulp and Papermaking Opportunities in Northern New Mexico", NM Department of State Forestry funded under Northern Rio Grande RC&D Project

Wallmon, Nathaniel - "Value of Water in Alternative Uses"

CHAPTER IX

Opportunities for Development and Impact of USDA Programs

This chapter deals with opportunities and recommendations for development of water and related land resources for which the Department of Agriculture can provide assistance. Physical and economic impacts expected from the potential projects and programs are shown. However, detailed investigations will be required before implementation takes place.

The program recommended for the basin consists of a land treatment and management program, structural measures in 19 watersheds to reduce floodwater and sediment not controlled by land treatment, and programs to provide water and sewerage services to rural communities.

Opportunities for land treatment in the basin are discussed. Estimates include acres needing treatment, cost, and expected returns both for the Early Action Period and for the remaining period to year 2020.

Potential projects and programs are discussed and evaluated in two time frames: Early Action (the next 10 to 15 years), and for the remaining period to year 2020.

Brief summaries of watershed investigation reports on 19 potential upland watershed projects are presented. Also included are summary tables showing estimated costs, benefits, and benefit-cost ratios.

Opportunities for improvement of land and water resources by using the Resource Conservation and Development programs are identified. Development opportunities for the cooperative State and Private Forestry Programs, National Forest Development, and Rural Electrification are also identified.

RECOMMENDED PROJECTS FOR DEVELOPMENT

POTENTIAL PUBLIC LAW 566 WATERSHED PROJECTS

Nineteen watersheds have potential for development under Public Law 566 and should be initiated during the Early Action Period. Detailed watershed investigation reports are in Appendix II. The watersheds are grouped according to their independence or interrelationship with one another. Benefits would include reduction in flood damage to municipalities, irrigation and drainage works, and public utilities. The Conservation Needs Inventory Watershed Number (CNI) follows the watershed name.

Estimated installation costs and distribution of installation cost between federal and non-federal funds are shown in Table IX-1, page IX-9. Benefit-cost ratios at 5-3/8 percent are shown in Table IX-2, page IX-10. Of the 19 potential watershed projects recommended as feasible for the Early Action Plan, three will have a benefit-cost ratio of less than unity when appraised at 5-7/8 and 6-1/8 percent interest rates. When appraised at 6-7/8 percent interest, six watershed projects will have a benefit-cost ratio of less than unity (Table IX-3, page IX-11). A reappraisal of the benefits expected to accrue and reformulation of potential projects may be necessary prior to request for planning authorization.

There are several communities in the basin which receive flood damages, however, flood protection measures cannot be economically justified under present USDA programs.

Independent Watersheds

Independent watersheds are those that do not have damage areas in common with other watersheds.

Red River Watershed (CNI 1-163)

The watershed is located in northern Taos County and includes Red River and its tributaries. The main problem is floodwater damage in the village of Red River. Pinyon and juniper control and management, commercial timber management, and sagebrush control and management are among the land treatment systems that will offer upstream watershed protection and economic opportunities. Potential structural measures include five floodwater retarding structures and one floodwater diversion. These structural measures would protect about 100 acres of highly developed urban and recreational land, benefiting 115 owners and operators of urban property.

Embudo River Watershed (CNI 1-151)

This watershed is located in the southern part of Taos County, east of the Rio Grande and involves the drainage of Embudo River and its tributaries. Problems are seasonal shortages of irrigation water and flood damage to irrigated cropland, irrigation facilities, rural residences, and public roads. Critical erosion area control, pinyon-juniper control

and management, and commercial timber management are among land treatment systems that offer upstream watershed protection and economic opportunities. Potential structural measures include six floodwater retarding structures that would reduce flood damages by approximately 80 percent. Agriculture water management measures would include drainage works for 1,850 acres of irrigated land and improved farm irrigation systems for 2,400 acres. Benefits would be to residences, cropland, public roads, bridges, culverts, and related appurtenances. Rehabilitation of irrigation delivery systems would benefit about 8,400 acres of irrigated land and 1,250 residences.

The Forest Service and the Bureau of Reclamation have investigated a potential dam site for recreation and streamflow regulation east of Penasco on Santa Barbara Creek.

Pojoaque Creek Watershed (CNI 1-144 and 1-145)

This watershed is located in northeastern Santa Fe County, south of Espanola and includes the Arroyo Seco, Pojoaque Creek, and Rio Tesuque drainages and their tributaries. The primary problem is floodwater and sediment damage along the main tributaries and side arroyos that enter Pojoaque Creek.

Pinyon-juniper control and management, control of critical erosion areas, and improved range management are among the land treatment systems that would provide upstream watershed protection and economic opportunities. Structural measures needed for a high degree of flood control include eight floodwater retarding structures. Only three of the structures appear to be economically justified under existing criteria. The structures would protect irrigation canals and ditches, irrigated cropland, business, and rural homes. Shortages of water for irrigation during the growing season could be partially corrected by reorganizing and rehabilitating distribution systems.

The Nambe Falls Dam on Nambe Creek planned by the Bureau of Reclamation has good possibilities for recreation and flood damage reduction benefits in addition to providing water for irrigation. The Corps of Engineers is also studying this watershed.

Santa Fe River Watershed (CNI 1-140)

This watershed is located in central Santa Fe County and consists of the Santa Fe River drainage. The major problems are floodwater and sediment damage in the city of Santa Fe. Much of the land in the northern part of the watershed has been changed from pinyon-juniper rangeland to residential areas. Improved range management, pinyon-juniper control, and control of critical erosion areas are among the land treatment systems that offer upstream protection and economic opportunities. The national forest lands are closed to all uses under regulations by the Secretary of Agriculture. Potential structural measures include three

single-purpose floodwater retarding structures to reduce the flow from arroyos to a level that the existing channel could safely convey to the Rio Grande.

The Corps of Engineers is assisting the City of Santa Fe by studying the possibility of providing flood control on the Santa Fe River above the city and channel improvement on the Santa Fe River and Mascaras Arroyo through the city.

Galisteo Creek Watershed (CNI 1-139)

The watershed is located in central Santa Fe and eastern Sandoval Counties and includes the drainage below Galisteo Dam. The main problem is two small arroyos east of Pena Blanca that cause floodwater and sediment damage to homes, businesses, irrigation canals and ditches, and irrigated cropland near Pena Blanca.

Control of critical erosion areas, improved range management, and pinyon-juniper control are among the land treatment systems that offer watershed protection and economic opportunities. Structural measures needed for flood prevention include two floodwater retarding structures with appurtenant outlet works. Agricultural water management measures include the drainage of 1,500 acres of irrigated land and improved farm irrigation systems for 1,100 acres. Potential floodwater retarding structures would provide protection to property in the village, to irrigation facilities, and to irrigated cropland.

The Corps of Engineers constructed Galisteo Dam, on Galisteo Creek 12 miles upstream from the junction of the creek and the Rio Grande, to protect urban and agricultural areas downstream.

Nacimiento & Rito Leche Creek Watershed (CNI 1e-12)

This watershed is located in Sandoval and Rio Arriba Counties in the vicinity of Cuba, 80 miles northwest of Albuquerque. The watershed has a drainage area of about 18 square miles. Floodwaters and sediment damage residential and business property in the town of Cuba and about 350 acres of irrigated land. This cropland is owned by about 50 operators and is used for the production of alfalfa, small grains, pasture, and gardens.

More intensive application of land treatment measures and better control of grazing are needed. To supplement land treatment measures, two floodwater retarding structures and two floodwater diversions are recommended to achieve the desired level of flood protection.

Rock Lake Watershed (CNI 1-107)

The watershed is located in Torrance County near Willard. The upper part is in the Manzano Mountains and covers approximately 156,000 acres. About 3,700 acres of the farmland are irrigated from wells.

The principal problems are flood damage to irrigated land and improvements, roads and railroads, erosion of land by wind, and a declining water table. Land treatment should stabilize the land and improve the vegetation. Gully plugs, contour furrows, diversion, grass seeding, and proper use of the grazing land are needed on one thousand acres of critically eroded areas. Revegetation of areas previously farmed is needed on about 26,000 acres and grazing management is needed on all of the rangeland.

Structural measures needed for flood prevention include two floodwater retarding structures and associated channels to protect about 3,700 acres of irrigated land and benefit six landowners. The structural measures would also provide public benefits by recharging additional floodwater into the underground basin.

Tajique Watershed (CNI 1-114)

This 98,600 acre watershed is located in the western part of Torrance County about ten miles north of Willard. The upper portion heads in the Manzano Mountains. About 5,000 acres are irrigated from wells.

Watershed problems are flood damage to irrigated land - state, county, and private roads, and the railroad; runoff that is lost to beneficial use; and erosion damage on poorly vegetated areas in the upper watershed.

The land treatment needed includes improved grazing management on 25,000 acres of grassland and treatment of 15,000 acres that have critical erosion problems. Treatment needed includes small gully plugs, contour furrows and diversion, grass seeding, and revegetating about 14,100 acres of land previously dry-farmed and not well vegetated.

Structural measures needed for flood prevention include one floodwater retarding dam located on Torreon Draw and Arroyo del Cuervo. Approximately 15 landowners on 3,000 acres of irrigated land would directly benefit from the installation of the floodwater retarding structure. Floodwater would be recharged into the underground basin.

Buffalo Springs Watershed (CNI 1-119)

The watershed is located in Torrance County and includes the towns of Estancia and Moriarity and the community of Chilili. The watershed covers approximately 238,000 acres and extends west into the Manzano Mountains. The farmland includes about 13,500 acres of irrigated land;

1,300 acres of dry cropland; and 35,200 acres of formerly cropped land not well vegetated. Irrigation water is pumped from wells developed by individual farm owners. The principal crops are alfalfa, corn, grain sorghum, potatoes, and small grains.

Principal watershed problems are flood damage to irrigated land, urban damage in Estancia, and damage to highways, roads, and the railroad.

Other significant problems are erosion by wind and water to unprotected upland areas of the watershed.

Feasible land treatment measures needed include improved grassland management on about 21,000 acres; pinyon-juniper control on 25,000 acres, timber stand improvement on 11,600 acres; and revegetation of 32,000 acres of land previously dry farmed.

Structural measures needed for flood prevention include four floodwater retarding structures. These measures would provide significant flood damage reduction benefits to approximately 1,200 residents in Estancia and 30 owners of irrigated cropland. Other benefits include damage reduction to highways, roads, and the railroad, and ground water recharge.

Hyer Draw Watershed (CNI 1-122)

The watershed is located in Torrance and Santa Fe Counties north and west of Moriarity and covers approximately 198,400 acres. The western part heads in the San Pedro and the South Mountains. Included are 11,000 acres of irrigated cropland; 2,200 acres of dry cropland; and 36,000 acres of formerly cropped land not well vegetated. Water for irrigation is pumped from wells developed by individual landowners.

Principal watershed problems are flood damage to irrigated land, roads, and highways; wind and water erosion on formerly dry farmed lands; and the loss of flood runoff.

Land treatment systems include improved management on 62,000 acres of grassland; pinyon-juniper control on 2,500 acres; critical erosion control on about 14,000 acres of formerly dry-farmed land; and the improvement of irrigation systems on about 7,000 acres of irrigated land.

Structural measures needed for flood prevention are two floodwater retarding structures. These structures would provide direct flood damage reduction benefits to 20 landowners with about 4,000 acres of irrigated land. Benefits to the public would be reduction of flood damage to roads and increased recharge to ground water.

Interrelated Watersheds - El Rio En Medio Sub-basin

The following nine watershed investigation summaries are in the Middle Rio Grande. These watersheds are interrelated because each damage the

irrigation system that serves the Middle Rio Grande Conservancy District and causes interruption of irrigation services to district lands. The diversion dams and canal are shown on the Watershed Interelationship El Rio En Medio Sub-basin map in Appendix II.

Pajarito Watershed (CNI 1-125)

The watershed is located on the west side of the Rio Grande and includes portions of Albuquerque. Numerous arroyos drain the slopes of the west mesa toward the Rio Grande. None of the arroyos have outlet channels to the river. Floodwaters from these arroyos pond above or empty into the main irrigation canals filling them with floodwater, sediment, debris, and flood the developed areas below the canal.

About 7,300 acres subject to flood damage are currently used for residential, small businesses, and isolated irrigated farms. Present indications are that within 25 years the damage area will be fully developed for residential and commercial use with a population of about 25,000. Five floodwater retarding structures with associated floodwater diversions and outlet channels are needed to provide adequate flood control.

Hell's Canyon Watershed (CNI 1-118)

This watershed covers about 183,872 acres and is located about ten miles south of Albuquerque. It includes parts of Bernalillo and Valencia Counties. The watershed drains a portion of the west slopes of the Manzano Mountains. Arroyos in the watershed originally had channels that drained into the Rio Grande. Floodwater and sediment damage roads, residences, irrigation facilities, farm equipment, and irrigated cropland. Damage from interrupted irrigation services occurs on about 4,000 acres of land.

There are approximately 400 farm homes, small businesses, and 9,000 acres of land subject to flooding. Five floodwater retarding structures and outlet channels are needed to provide adequate flood control.

Canyon Sales Watershed (CNI 1-115)

This watershed is in central Valencia County about 25 to 30 miles south of Albuquerque with an area of about 147,100 acres. The drainage pattern is generally to the west. The arroyos originally drained into the Rio Grande but in recent years the bottomland along the Rio Grande has been developed into irrigated cropland. These arroyos now drain into the main irrigation canal and flood the lands below the canal.

About 1,000 acres of irrigated cropland are damaged from interruption of irrigation services and another 1,000 acres are damaged by flooding. Several homes, highways, bridges, and farm roads are damaged frequently. The desired level of flood protection would be provided by three floodwater retarding structures and related channel improvements.

Pino Draw Watershed (CNI 1-104)

This watershed is located in the northeastern part of Socorro County about 27 miles north of Socorro and east of the Rio Grande. The arroyos in this watershed have no outlets to the river but empty into and overflow canal banks and flood irrigated farmland below. About once every three years 1,000 acres of irrigated land are damaged and delivery of irrigation water to approximately 5,600 acres of cropland is interrupted. Several homes are damaged in the communities of Las Nutrias and Veguita by floods. Highways and bridges are damaged annually and three or four miles of State Highway 47 must be cleared of sediment each time the arroyos flood. Five floodwater retarding structures with associated outlet channels are needed to provide adequate protection.

Lemitar-Polvadera Watershed (CNI 1-99)

This watershed is about four miles north of Socorro on the west side of the Rio Grande and covers about 32,200 acres. About 3,000 acres of agricultural and urban land are subject to flooding. There are about 70 to 80 homes and small businesses located in the damage area and 25 farms. Some irrigated land is damaged nearly every year by floods. All of the arroyos terminate against the Lemitar-Polvadera canal. Sediment damage to the canal results in high maintenance costs.

Recommended improvements for cropland include land leveling, ditch lining, pasture and hayland management, and irrigation water management. In addition to proper grazing use, rangeland should have small gully control structures, erosion control measures, surface roughening, critical area seeding, and brush control. A plan for flood control consists of four potential floodwater retarding structures with associated channel improvements and diversions.

Walnut Creek Watershed (CNI 1-89)

This watershed is in central Socorro County just south of the City of Socorro and includes about 78,500 acres. Floodwater and sediment damage the railroad, roads, bridges, residences, irrigation facilities, farm equipment, and irrigated cropland. Floodwater from the arroyos flows directly into the main irrigation canal overtopping the canal bank and inundating cropland below. About 700 acres of cropland are damaged from floods. Damage from interrupted irrigation service occurs to an additional 2,900 acres of land. County roads are damaged annually from flood flows. Homes and businesses are frequently damaged in the communities of Luis Lopez and San Antonio.

Twelve floodwater retarding structures are needed to provide adequate protection from flood damage. There are no existing channels to the river. Outlet channels to the river will have to be installed to control the principal spillway discharge.

Interrelated Watersheds - Grants Area

Three watersheds in the Grants area are grouped together because they have a common damage area and require a common outlet channel. The location and interrelationship of these watersheds are shown on the Watershed Interrelationship Grants sub-basin Map in Appendix II.

These three watersheds should be planned simultaneously to effectively utilize watershed planning resources and arrive at the most economical combinations of structural measures. The three watersheds individually and combined have resulted in flooding and sediment deposition in Grants, Milan, and on irrigated cropland. There are approximately 200 homes and other major improvements subject to flooding. In August and September 1967 heavy rains in the area caused extensive damage in Grants to streets, bridges, homes, and businesses. On four occasions the sewerage disposal plant was completely inundated by water.

San Mateo-Grants Canyon Watershed (CNI 1e2-10)

This watershed is located in McKinley and Valencia Counties and contains about 213,700 acres including the town of Grants, the Homestake Uranium Plant, and the village of Milan. Structural measures needed for flood control consist of four floodwater retarding structures and a major by-pass channel around Grants.

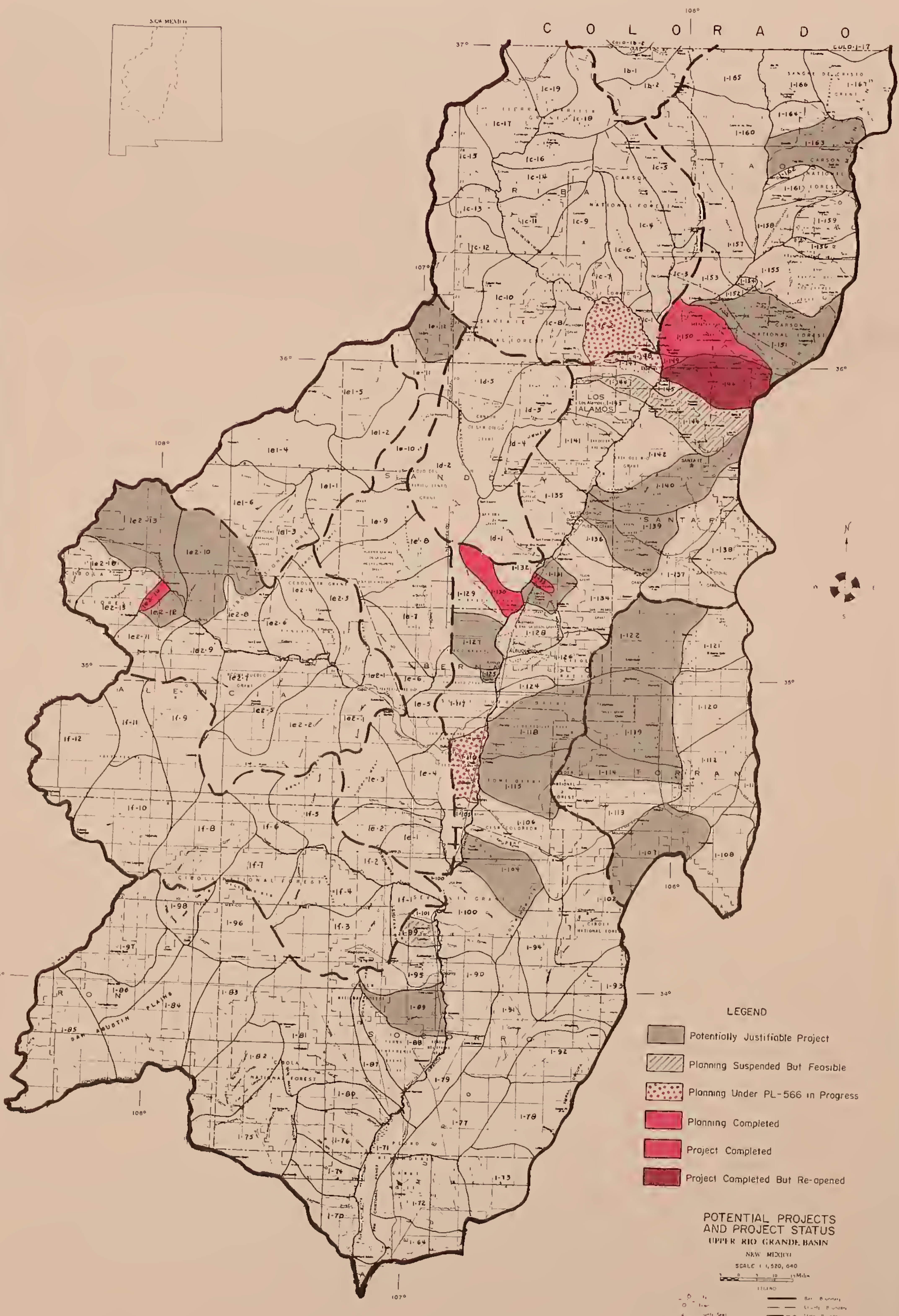
Pole Zuni Canyons Watershed (CNI 1e2-12)

This watershed is a tributary to the Rio San Jose, which passes through Milan and Grants. The drainage area is about 67,000 acres. Much of the residential and business developments in Grants and Milan are in the floodplain. The watershed contains about 2,900 acres of previously irrigated cropland now idle because of flood damage and a shortage of irrigation water. Three floodwater retarding structures and related diversions are needed for flood prevention.

Rio San Jose Watershed (CNI 1e2-13)

This watershed is located generally north of the village of Bluewater, in the northern edge of Valencia County and the southcentral part of McKinley County. It covers about 224,600 acres. There are about 1,500 acres of irrigated farmland in the watershed, much of which is subject to floodwater and sediment damage. The Atchison, Topeka and Santa Fe Railroad and Interstate Highway US-40 pass through the watershed. The Rio San Jose drainage contributes floodwater to the urban areas of Grants and Milan. Structural measures needed for flood protection are two floodwater retarding structures with related channel improvements.

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO



JULY 1970

NOVEMBER 1974 4-R-34445

TABLE IX-1. ESTIMATED COSTS OF STRUCTURAL MEASURES AND DISTRIBUTION OF COSTS BETWEEN FEDERAL FUNDS AND NON-FEDERAL FUNDS ON POTENTIAL WATERSHED PROJECTS, UPPER RIO GRANDE BASIN, NEW MEXICO

Name and CNI Number of Watershed	1969 Price Base (Dollars)		
	Estimated Total Cost of Installation	Estimated Federal Cost of Installation	Estimated Non-Federal Cost of Installation
INDEPENDENT WATERSHEDS			
Rio Grande Tributaries			
1. Red River (1-163)	3,567,200	3,542,000	25,200
2. Embudo River (1-151)	1,432,200	1,271,500	160,700
3. Pojoaque Creek (1-144)	3,046,100	3,030,000	16,100
4. Santa Fe River (1-140)	1,373,100	1,327,000	46,100
5. Galisteo Creek (1-139)	229,900	224,700	5,200
6. Nacimiento & Rito Leche Creek (1e-12)	1,082,000	1,037,000	45,000
Sub Total	10,730,500	10,432,200	298,300
Estancia Closed Basin			
7. Rock Lake (1-107)	2,482,000	2,445,100	36,900
8. Tajique (1-114)	1,366,000	1,240,500	125,500
9. Buffalo Springs (1-119)	2,934,800	2,865,700	69,100
10. Hyer Draw (1-122)	3,780,700	3,614,500	166,200
Sub Total	10,563,500	10,165,800	397,700
INTERRELATED WATERSHEDS			
Rio Grande Tributaries			
11. Pajarito (1-125)	5,039,000	4,017,000	1,022,000
12. Hell's Canyon (1-118)	6,280,000	6,133,000	147,000
13. Canyon Sales (1-115)	1,679,000	1,607,000	72,000
14. Pino Draw (1-104)	2,615,000	2,569,000	46,000
15. Lemitar-Polvadera (1-99)	1,954,000	1,938,000	16,000
16. Walnut Creek (1-89)	4,200,000	4,115,000	85,000
Sub Total	21,767,000	20,379,000	1,388,000
Grants Subbasin			
17. San Mateo-Grants Canyon (1e2-10)	1,704,000	1,322,000	382,000
18. Pole Zuni Canyons (1e2-12)	432,000	411,000	21,000
19. Rio San Jose (1e2-13)	1,501,000	1,494,000	7,000
Sub Total	3,637,000	3,227,000	410,000
BASIN TOTAL	46,698,000	44,204,000	2,494,000

Source: Soil Conservation Service Watershed Investigation Report

TABLE IX-2. SUMMARY COSTS AND BENEFITS OF POTENTIAL WATERSHED PROJECTS, UPPER RIO GRANDE BASIN, NEW MEXICO

Name and CNI Number of Watershed 1/		Structural Measures: Average 2/ Annual Costs $	Average 3/ Annual Benefits $	Benefit-Cost Ratio
INDEPENDENT WATERSHEDS				
Rio Grande Tributaries				
1. Red River	(1-163)	199,900	228,600	1.1:1
2. Embudo River	(1-151)	80,800	126,600	1.6:1
3. Pojoaque Creek	(1-144)	167,900	161,100	1.0:1
4. Santa Fe River	(1-140)	78,400	79,000	1.0:1
5. Galisteo Creek	(1-139)	12,800	14,900	1.2:1
6. Nacimiento & Rito Leche Creek	(1e-12)	61,200	79,600	1.3:1
Sub Total		601,000	689,800	
Estancia Closed Basin				
7. Rock Lake	(1-107)	148,100	168,800	1.1:1
8. Tajique	(1-114)	83,800	84,500	1.0:1
9. Buffalo Springs	(1-119)	174,600	195,000	1.1:1
10. Hyer Draw	(1-122)	231,300	306,700	1.3:1
Sub Total		637,800	755,000	
INTERRELATED WATERSHEDS				
Rio Grande Tributaries				
11. Pajarito	(1-125)	291,000	421,500	1.4:1
12. Hell's Canyon	(1-118)	356,300	423,100	1.2:1
13. Canyon Sales	(1-115)	95,600	127,500	1.3:1
14. Pino Draw	(1-104)	149,900	206,600	1.4:1
15. Lemitar-Polvadera	(1-99)	111,800	122,300	1.1:1
16. Walnut Creek	(1-89)	238,600	298,000	1.2:1
Sub Total		1,243,200	1,599,000	
Grants Subbasin				
17. San Mateo-Grants Canyon	(1e2-10)	103,500	112,400	1.1:1
18. Pole Zuni Canyons	(1e2-12)	25,200	37,200	1.5:1
19. Rio San Jose	(1e2-13)	88,600	153,600	1.7:1
Sub Total		217,300	303,200	
BASIN TOTAL		2,699,300	3,347,000	1.2:1

1/ Numerical listing does not imply priority
2/ Installation costs amortized @ 5-3/8 percent interest for 100 years. Includes $2,523,600 as the amortized cost of installation and average annual estimated operation and maintenance cost of $175,700.
3/ Price Base: Agricultural - Adjusted Normalized Prices Nonagricultural - 1969 Prices
Source: Soil Conservation Service Watershed Investigation Report

TABLE IX-3. BENEFIT-COST RATIOS FOR DIFFERENT INTEREST RATES - 100 YEAR EVALUATION PERIOD

Name and CNI Number of Watershed		5-5/8 PERCENT Average Annual Benefit	5-5/8 PERCENT Average Annual Cost	5-5/8 PERCENT Benefit Cost Ratio 1/	5-7/8 PERCENT Average Annual Benefit	5-7/8 PERCENT Average Annual Cost	5-7/8 PERCENT Benefit Cost Ratio 1/	6-1/8 PERCENT Average Annual Benefit	6-1/8 PERCENT Average Annual Cost	6-1/8 PERCENT Benefit Cost Ratio 1/	6-7/8 PERCENT Average Annual Benefit	6-7/8 PERCENT Average Annual Cost	6-7/8 PERCENT Benefit Cost Ratio 1/
INDEPENDENT WATERSHEDS													
Rio Grande Tributaries													
1. Red River	(1-163)	$228,500	$208,500	1.1:1	$230,500	$217,300	1.1:1	$232,300	$226,100	1.0:1	$238,000	$252,600	0.9:1
2. Embudo River	(1-151)	126,600	84,900	1.5:1	127,300	88,400	1.4:1	128,000	92,000	1.4:1	130,300	102,500	1.3:1
3. Pojoaque Creek	(1-144)	162,800	175,800	0.9:1	164,400	183,200	0.9:1	166,000	190,700	0.8:1	168,500	211,500	0.8:1
4. Santa Fe River	(1-140)	78,400	81,900	0.9:1	79,200	85,100	0.9:1	79,900	88,500	0.9:1	82,100	98,700	0.8:1
5. Galisteo Creek	(1-139)	14,900	13,400	1.1:1	15,100	14,000	1.1:1	15,200	14,500	1.0:1	15,500	16,200	1.0:1
6. Nacimiento & Rito Leche Creek	(1e-12)	80,700	63,800	1.3:1	81,300	66,500	1.2:1	81,800	69,100	1.2:1	83,400	77,200	1.0:1
Estancia Closed Basin													
7. Rock Lake	(1-107)	171,800	154,200	1.1:1	173,500	160,300	1.1:1	175,200	166,400	1.1:1	180,200	184,900	1.0:1
8. Tajique	(1-114)	84,200	87,200	1.0:1	85,100	90,500	0.9:1	86,000	93,900	0.9:1	88,400	104,000	0.8:1
9. Buffalo Springs	(1-119)	194,900	181,800	1.1:1	196,800	189,000	1.0:1	198,800	196,200	1.0:1	204,700	218,000	0.9:1
10. Hyer Draw	(1-122)	306,600	240,600	1.3:1	309,100	249,900	1.2:1	311,600	259,200	1.2:1	319,200	287,600	1.1:1
INTERRELATED WATERSHEDS													
Rio Grande Tributaries													
11. Pajarito	(1-125)	426,100	303,400	1.4:1	428,300	315,700	1.4:1	430,600	328,400	1.3:1	437,400	365,600	1.2:1
12. Hell's Canyon	(1-118)	429,700	371,700	1.2:1	432,900	387,100	1.1:1	436,200	402,600	1.1:1	446,000	449,200	1.0:1
13. Canyon Sales	(1-115)	129,300	99,700	1.3:1	130,100	103,900	1.3:1	131,000	108,000	1.2:1	133,500	120,500	1.1:1
14. Pino Draw	(1-104)	209,400	156,300	1.4:1	210,700	162,800	1.3:1	212,100	169,200	1.3:1	216,300	188,600	1.1:1
15. Lemitar-Polvadera	(1-99)	124,400	116,600	1.1:1	125,400	121,400	1.0:1	126,500	126,200	1.0:1	129,500	115,900	1.1:1
16. Walnut Creek	(1-89)	302,400	248,900	1.2:1	304,600	259,200	1.2:1	306,800	269,500	1.1:1	313,500	300,700	1.0:1
Rio San Jose													
17. San Mateo-Grants Canyon	(1e2-10)	114,000	107,800	1.1:1	114,800	111,900	1.0:1	115,600	116,200	1.0:1	118,000	128,700	0.9:1
18. Pole-Zuni Canyons	(1e2-12)	37,600	26,200	1.4:1	37,900	27,300	1.4:1	38,100	28,300	1.3:1	38,800	31,500	1.2:1
19. Rio San Jose	(1e2-13)	115,200	92,300	1.7:1	156,000	96,000	1.6:1	156,800	99,700	1.6:1	159,300	110,800	1.4:1

1/ Benefit/cost ratios expressed to the nearest tenth. Benefit/cost ratios would be improved to some extent by using current normalized prices. 1969 price base.

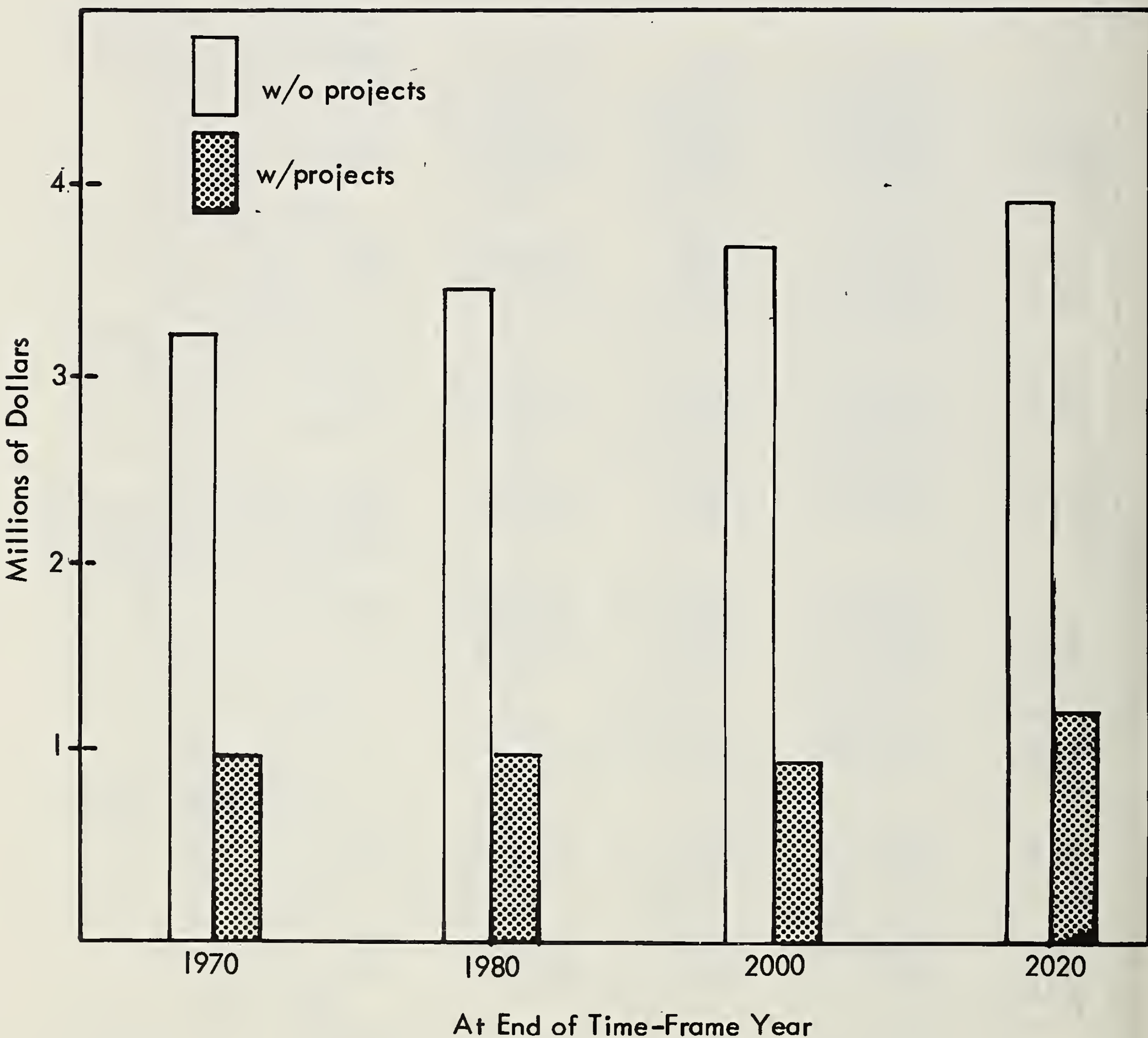


FIGURE IX-1. AVERAGE ANNUAL FLOOD DAMAGE, UPPER RIO GRANDE BASIN (WITH AND WITHOUT FLOOD PREVENTION PROJECTS) (UPLAND WATERSHEDS)

LAND TREATMENT UNDER USDA AUTHORITIES

Land treatment and/or management systems are logical combinations of applicable land treatment and management practices that are needed to correct problems or maximize productivity on particular types of lands. Improved management, vegetative improvement, and mechanical treatment of the lands within the basin can enhance the economy as well as preserve the resource base. Land treatment systems can be planned and applied to increase the production of crops, forage, wood, water, meat, and reduce erosion and damaging sediment deposition.

The River Basin Field Party has estimated that the land treatment amounts shown in Table IX-4, page IX-14, should be initiated in the next 10 to 15 years (Early Action Period). Table IX-5, page IX-15, shows the remaining needs and potential land treatment to the year 2020. Both monetary and selected physical impacts are indicated in these tables.

COOPERATIVE STATE AND FORESTRY PROGRAMS

Treatment opportunities for development are in the fields of management, tree planting, marketing, utilization, and timber stand improvement work, both for commercial and non-commercial areas of privately owned lands. There are approximately 717,000 acres of state and private commercial timberlands in the basin. Many owners have highly productive lands but are not interested in the management of these timber lands. Development of fast growing hybrids and the introduction of exotic species are possible developments. A superior hybrid of cottonwood developed in the southern United States may have opportunities in the Rio Grande Basin for pulp production. An exotic species of pine from Afghanistan grew 14-1/2 feet in five years here in New Mexico. It appears that this tree could produce high quality Christmas trees and cut the present rotation period in half. This species may also have potential for pulp wood production.

The Office of the State Forestry is organized to provide fire protection on all non-municipal state and private lands. The department is in the process of training fire districts and volunteer fire associations to suppress wildfires. The State Forester is working with 20 volunteer fire organizations within the state and there is potential to set up approximately 200 such groups. Fire equipment and training are made av. available to the groups. New state fire laws and regulations are necessary to develop a strong fire prevention program. A Rural Fire Defense Program is being considered by Congress to provide technical services and fire equipment for rural and small community protection.

TABLE IX-4. ESTIMATED LAND TREATMENT NEEDS AND OPPORTUNITIES FOR EARLY ACTION PROGRAM (NEXT 10 TO 15 YEARS), UPPER RIO GRANDE BASIN, NEW MEXICO

Land Treatment Systems by Major Management Areas	Acres Needing Treatment this Period	Monetary Impacts: Cost of Applying Treatment ($) 1/	Average Annual Cost of Applying Treatment ($) 2/	Average Annual Returns ($)	Physical Impacts 6/: Water Savings/ Increased Water Yield ac-ft/yr	Sediment Reduction ac-ft/yr 7/	Soil Loss Reduction tons/yr.	Increased Forage Yields tons/yr.	Added Employment man-yrs per yr.
1. Grassland									
1c. Range Management	991,000	5,450,000	428,000	798,000	-	41	218,600	49,600	15
2. Grazable Woodland									
2a. Pinyon-Juniper Control	175,400	2,631,000	191,100	289,000	1,400	5	34,200	8,800	6
2b. Ponderosa Pine, Pinyon-Juniper Mgt.	481,000	1,927,000	140,000	550,000	4,000	26	162,800	24,200	4
3. Brushland									
3a1. Sagebrush Control	16,800	134,000	10,400	55,000	-	2	10,400	4,200	1
3b1. Sagebrush Management	23,200	92,800	7,300	24,300	-	2	11,200	1,200	-
3a2. Chapparal Control	7,200	108,000	8,400	21,800	-	1	4,500	1,800	1
3b2. Chapparal Management	9,300	74,200	5,800	9,200	-	1	3,600	500	-
3b3. Creosotebush Management	20,600	82,000	6,400	9,500	-	1	8,400	-	1
3a4. Mesquite Bush Control	15,000	150,000	11,700	25,800	-	2	10,000	1,500	1
3a5. Rabbitbrush Control	6,400	51,200	4,000	10,500	-	1	4,000	600	-
3b5. Rabbitbrush Management	6,600	26,400	2,100	8,800	-	-	2,500	700	-
3a6. Yucca Control	1,600	12,800	1,000	1,000	-	-	-	100	-
5. Bottomland									
5b. Bottomland Management	3,800	19,000	1,400	1,800	-	-	-	200	-
6. Cropland, Hayland and Pastureland									
6a1. Drainage	7,600	190,000	20,500	194,500 3/	-	-	-	-	1
6a2. Improved Irrigation Systems	46,000	5,060,000	395,800	1,254,500 4/	13,300	-	-	-	22
6b. Dryland Management	11,300	56,500	4,400	12,800 5/	-	-	1,600	-	-
6c. Abandoned Cropland Management	35,000	525,000	38,100	170,800	-	1	6,800	17,600	1
8. Management and Treatment of Critical Erosion Areas	1,178,000	17,700,000	1,296,000	2,124,800	-	446	914,800	59,000	39
TOTAL	3,035,800	34,269,900	2,572,400	5,562,100	18,700	529	1,393,400	170,000	92
Estimated Average Annual Operation and Maintenance Cost	-	-	350,000	-	-	-	-	-	-
Total Average Annual Costs and Returns	-	-	2,922,400	5,562,100	-	-	-	-	-

1/ 1970 costs.
2/ Estimated application costs amortized @ 6 percent over expected life of each treatment measure.
3/ Includes value of increased crop production $190,000.
4/ Includes value of increased crop production $690,000.
5/ Includes value of increased crop production $11,300.
6/ Values rounded to nearest whole number for sediment reduction and employment and to nearest 100 on the other impacts. Monetary Values estimated by SCS field party members and based on Secondary data and field observations: (A) Water, $35 ac-ft; (b) Sediment damage reduction, $1,129 ac-ft; (c) Soil nutrients, $1 per ton of soil loss; (d) forage $9 per ton; and (e) $4,500 per man-year of employment for application of land treatment program.
7/ Sediment deposition in floodplain and/or damage area.

TABLE IX-5. ESTIMATED LAND TREATMENT NEEDS AND OPPORTUNITIES (AFTER EARLY ACTION PROGRAM) TO YEAR 2020, UPPER RIO GRANDE BASIN, NEW MEXICO

Land Treatment Systems by Major Management Areas	Monetary Impacts: Remaining Acres Needing Treatment to 2020	Monetary Impacts: Estimated Costs of Applying Treatment ($) 1/	Monetary Impacts: Average Annual Cost of Applying Treatment ($) 2/	Monetary Impacts: Average Annual Returns ($)	Physical Impacts 7/: Water Savings & Increased Water Yield ac-ft/yr	Physical Impacts 7/: Sediment Reduction ac-ft/yr 6/	Physical Impacts 7/: Soil Loss Reduction tons/yr	Physical Impacts 7/: Increased Forage Yields tons/yr	Physical Impacts 7/: Added Employment man-yrs per yr.
1. Grassland									
1b. Snowpack Management	4,100	348,500	27,300	32,600	700	-	3,600	-	1
1c. Range Management	3,966,800	21,818,000	1,711,000	3,200,000	-	164	1,049,400	198,400	40
2. Grazable Woodland									
2a. Pinyon-Juniper Control	701,600	10,524,000	764,600	789,300	5,900	22	136,700	35,200	20
2b. Ponderosa Pine, Pinyon-Juniper Mgt	1,928,100	7,709,400	560,100	2,279,800	16,000	107	651,000	96,800	17
3. Brushland									
3a1. Sagebrush Control	67,000	536,400	42,000	205,100	-	7	41,500	16,800	1
3b1. Sagebrush Management	92,800	371,200	29,000	99,700	-	8	44,800	4,600	1
3a2. Chapparal Control	28,800	432,000	33,800	92,000	-	4	18,200	7,200	1
3b2. Chapparal Management	37,100	297,000	23,200	38,500	-	3	14,400	1,800	1
3b3. Creosotebush Management	82,400	329,600	25,800	43,600	-	5	33,500	-	1
3a4. Mesquite Bush Control	60,000	600,000	47,000	105,200	-	6	39,900	6,000	1
3a5. Rabbitbrush Control	25,600	204,800	16,000	46,400	-	2	16,200	2,600	1
3b5. Rabbitbrush Management	26,400	105,600	8,200	35,900	-	2	10,200	2,600	-
3a6. Yucca Control	1,600	12,800	1,000	1,000	-	1	-	-	-
4. Forest Land									
4a. Spruce-Fir, Mixed Conifer Mgt	143,000	5,720,000	344,200	960,500	23,800	6	37,900	7,200	4
4b. Ponderosa Pine Management	391,000	11,730,000	705,900	905,000	16,300	17	103,000	19,600	8
4c. Aspen Management	36,000	1,080,000	65,000	242,600	6,000	2	-	-	-
5. Bottomland									
5a. Phreatophyte Control	86,300	8,362,500	1,418,500	5,516,000	146,800 5/	-	-	38,000	8
5b. Bottomland Management	15,000	75,000	5,400	6,300	-	-	-	700	-
6. Cropland, Hayland and Pastureland									
6a1. Drainage	30,300	757,500	81,700	771,000 3/	-	-	-	-	3
6a2. Improved Irrigation Systems	106,900	11,759,000	919,900	2,739,000 4/	29,100	-	-	-	26
6c. Abandoned Cropland Management	82,200	1,233,000	89,600	401,800	-	3	15,900	41,000	3
8. Management and Treatment of Critical Erosion Areas	1,179,600	17,664,000	1,283,000	2,123,200	-	446	913,200	59,000	39
TOTAL	9,092,600	101,670,300	8,041,200	20,634,500	244,600	805	3,129,400	537,500	176
Estimated Average Annual Operation and Maintenance	-	-	1,351,000	-	-	-	-	-	-
Total Average Annual Costs and Returns	-	-	9,392,200	20,634,500	-	-	-	-	-

1/ 1970 costs.
2/ Estimated application cost amortized @ 6 percent interest over expected life of treatment measure.
3/ Includes value of increased crop production of $757,500.
4/ Includes value of increased crop production of $1,603,500.
5/ Adds 91,800 acre-feet of water to the existing supply plus 55,000 acre-feet of savings by preventing expansion of bottomland vegetation. This treatment includes subsurface drains in the treated area.
6/ Sediment depsoition in the floodplain or damage area.
7/ Values rounded to nearest whole number for sediment reduction and employment and to nearest 100 on the other impacts.

TABLE IX-6. ESTIMATED NATIONAL FOREST DEVELOPMENT PROGRAMS BASED ON THE PROJECT WORK INVENTORY, UPPER RIO GRANDE BASIN, NEW MEXICO

Item 1/	Unit	Quantity	Unit Cost	Early Action 10-15 years Quantity	Early Action 10-15 years Cost	Remainder of Remedial Program Quantity	Remainder of Remedial Program Cost
Re and Afforestation	Acres	57,189	$ 60.00	24,000	$ 1,440,000	33,189	$ 1,991,340
Timber Stand Improvement	Acres	467,000 2/	20.00	245,371	4,907,420	221,629	4,432,580
Fuel Treatment, snag felling	Acres	162,265	40.00	100,000	4,000,000	62,265	2,490,600
Fuel Treatment, slash disposal	Acres	151,906	40.00	100,000	4,000,000	51,906	2,076,240
Erosion Control, gully	Miles	3,809	3,750.00	3,000	11,250,000	809	3,033,750
Erosion Control, sheet	Acres	240,555	21.00	130,000	2,730,000	110,555	2,321,655
Erosion Control, streambank	Miles	267	1,100.00	267	293,700	-	-
Erosion Control, abandoned roads and trails	Miles	3,918	900.00	2,500	2,250,000	1,418	1,276,200
Sediment Basin Construction	Acres	688	4,000.00	300	1,200,000	388	1,552,000
Riparian Vegetation Management	Acres	1,250	30.00	1,000	30,000	250	7,500
Snow Pack Management (fences)	Miles	136	20,367.00	25	500,000	111	2,220,000
Noxious Plant Control, Type Conversion and Seeding	Acres	380,895	35.00	150,000	5,250,000	230,895	8,081,325
Fences	Miles	2,008	1,200.00	2,008	2,409,600	-	-
Range Water Development, springs	Each	271	100.00	150	15,000	121	12,100
Range Water Development, wells	Each	123	5,000.00	60	300,000	63	315,000
Range Water Development, earthen tanks	Each	446	600.00	100	60,000	346	207,600
Range Water Development, trick tanks	Each	103	6,000.00	50	300,000	53	318,000
Range Water Development, pit tanks	Each	34	600.00	34	20,400	-	-
Wildlife Watering Facilities	Each	69	1,000.00	69	69,000	-	-
Fish Habitat Improvement, streams	Miles	406	1,200.00	200	240,000	206	247,200
Fish Habitat Improvement, lakes	Acres	119	50.00	119	5,950	-	-
Recreation family unit	Each	31,658 3/	1,500.00	1,500	2,250,000	30,158	45,237,000

1/ Many of the items are included in Tables IX-15, pages IX-34 and 35, and IX-16, page IX-37 for land treatment in the basin.
2/ Based on Site Classes I and II for ponderosa pine.
3/ Based on National Forest Recreation Plan.

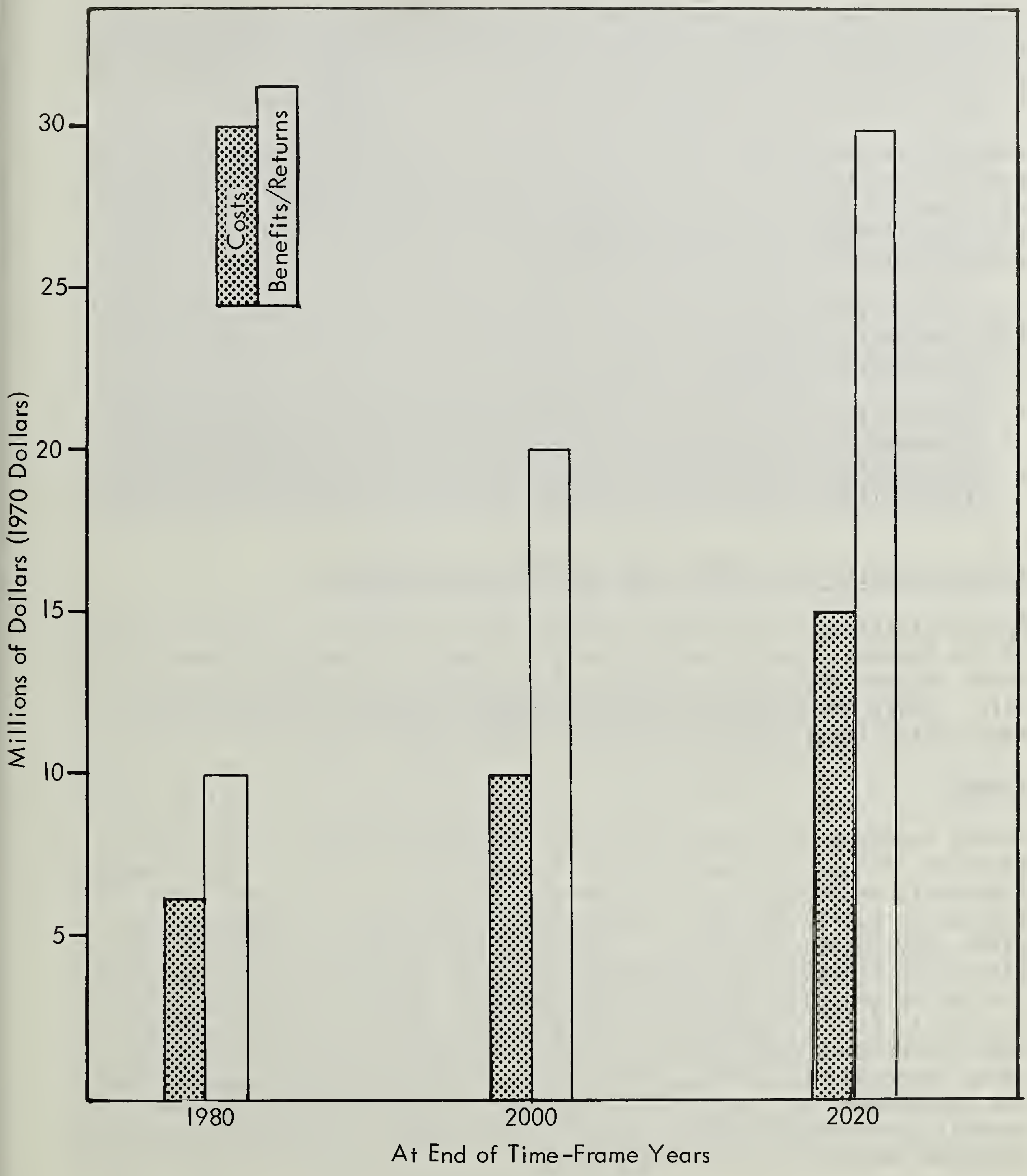


FIGURE IX-2. AVERAGE ANNUAL COSTS, BENEFITS, AND RETURNS FROM BASIN REMEDIAL PROGRAMS, UPPER RIO GRANDE BASIN, NEW MEXICO. SOURCE: FIELD PARTY RIVER BASIN INVESTIGATIONS

Cooperative tree distribution offers opportunities to increase the tree planting program. It is estimated that this distribution program could be increased to a million trees by an aggressive extension program. An Extension Forester is being considered by the State Extension Service.

Congress is considering legislation for an urban forestry program to provide services for urban and small communities. This would include all types of forestry planning and technical services, such as tree planting, insect and disease control, etc., for park areas, highways, urban development, etc.

The Rural Environmental Conservation Program (RECP), authorized by the 1973 Farm Bill, provides two cost-sharing programs for non-industrial private forest landowners. They are:

1. The Rural Environmental Assistance Program (REAP) contains private forestry provisions which cover primarily conservation measures.
2. The Forestry Incentives Program (FIP) which focuses on increasing future timber supplies.

NATIONAL FOREST DEVELOPMENT AND MULTIPLE USE PROGRAMS

Opportunities for development include better management and protection of the National Forest lands to meet the needs and desires of man. This would sustain production of water, wood, forage, recreation, and wildlife. There are manny possible development programs, and Table IX-6, page IX-16, lists some based on the Project Work Inventory.

Timber

Timber resource development opportunities encompass the cultural practices of thinning and regeneration for adequate stocking. Approximately 6 percent, or 94,860 acres, of commercial acreage are classed as non-stocked to poorly stocked. Timber stand improvement is presently applied only to ponderosa pine. There are approximately 52,000 acres of Site I and 415,000 acres of Site II areas of Ponderosa pine type. (Site Indices is growth of dominant and coordinate trees in 100 years. Site I is 75'+, Site II is 54'-74', and Site III is 53' or less). Forest tree improvement opportunities exist in producing and favoring genetically improved stock through selection and protection of superior trees. The development of a nursery in the basin is an opportunity to develop naturally resistant trees to local climate, insect and disease, and help overcome the problems of regeneration.

Water

Every acre of land can be considered as watershed and every use has some effect. Some opportunities for increasing water yield are through block and stripcutting of timber. The commercial timbered acreage of

PHOTO IX-1. NEW SAWMILL AT ESPANOLA, NEW MEXICO CREATES NEW JOBS FOR LOCAL PEOPLE

spruce-fir, mixed conifer, and aspen represents only four percent (769,000 acres) of the total basin. Snowpack management in the alpine grassland is of limited possibility. Desirable and suitable areas are often in conflict with wilderness areas. Opportunities for watershed stabilization are contained in various erosion control measures aimed specifically at sediment reduction.

Range

Intensive management offers the greatest opportunities to increase production of livestock as well as watershed protection. Grazing increase in AUM's (animal unit month) can be achieved through execution and followup of range management plans on the 310 allotments. There are some ranges that have a potential higher than present obligations, while others require adjustments as an initial step in range improvement. It is anticipated that the total carrying capacity can be increased an average of 20 percent. Programs for increased production include intensive grazing management systems, land treatment practices, and proper installation of range improvement structures.

Recreation

Almost unlimited opportunities for a variety of outdoor recreation exist on the National Forest lands. According to the National Forest

Recreation Plan (National Forest Recreation Survey and Bureau of Outdoor Recreation projections applied to 1968 figures), by year 2000 about 9,045 acres of additional lands will be developed for picnic and campground needs. The developments will have 31,658 units providing facilities for 158,290 people at one time. There is also an estimated need of 478 acres for winter sports. Highly desirable recreation areas, now privately owned, may be acquired with funds available through the Land Acquisition Program and Land and Water Conservation (Golden Eagle) Fund.

Wildlife

There are opportunities for maintaining the quality of wildlife and fish habitat through coordination of other uses. This can be accomplished by encouraging propagation of the natural population of native species. To maintain the wildlife population at the highest level consistent with other uses of the land, range plant management and treatment objectives must include improvements of the wildlife carrying capacity. Some opportunity exists for stocking wildlife species and to relocate or extend the existing habitat.

The Project Work Inventory (Table IX-6, page IX-16) indicates that on National Forest land the following wildlife habitat projects are needed and recommended: 406 miles of stream and 119 acres of lake improvement for fish; and 69 wildlife watering facilities.

WILD AND SCENIC RIVERS

The Wild and Scenic Rivers Act of 1968 designated eight rivers, or portions of rivers, to be preserved in their natural, free-flowing condition in order to enhance the recreational, scenic, geologic, fish and wildlife, historic, and cultural qualities.

A portion of the Rio Grande from the Colorado Border to State Highway 96, plus the lower four mile part of the Red River, was one of the eight original designations and is under the administration of the Department of Interior.

Four Wild and Scenic Rivers in the United States are under the administration of the Department of Agriculture.

In the basin, almost 200 miles of live streams have been recognized as "free-flowing". Studies of these rivers may reveal that certain streams deserve to be recognized as Wild and Scenic and should be administered by USDA.

RESOURCE CONSERVATION AND DEVELOPMENT PROGRAM - PUBLIC LAW 87-703

Many of the proposed "Opportunities for Development" listed in this chapter can be promoted and some can be partially financed under this program. These opportunities include (1) land treatment, (2) floodwater protection, (3) irrigation water management, (4) water based recreation, and (5) community development needs such as domestic water, sewage and solid waste disposal.

Other recommended project measures that could be developed under RC&D authorities in cooperation with other agencies are:

1. Marketing cooperatives.
2. Skiing facilities in the Cumbres Pass and Mount Taylor areas.
3. Improved crop production.
4. Recreational areas development.
5. Encourage development of low-water consuming industries such as (a) pressed board or pressed wood plant, which would utilize sawmill residue now burned as scrap, (b) firewood marketing, using scrap wood from sawmill operations, and (c) growing, managing, and harvesting of Christmas trees.
6. Develop nature trails along the Continental Divide and selected areas.
7. Develop a canning and/or food processing plant.
8. Accelerated conservation planning on those lands proposed for intensive land treatment.
9. Develop small industries utilizing the basin-grown produce.
10. Develop and manage wildlife habitat.

MUNICIPAL WATER AND SEWERAGE SYSTEMS

Rural development and improvement will enhance and help stabilize the overall economic growth in the Upper Rio Grande Basin. Small industries and businesses will ordinarily be attracted first to those communities that can provide public utilities in addition to labor forces and raw materials. One of the most acute basin needs and opportunities is to provide the small communities with domestic water supplies and sewerage systems. Of the 95 communities in the basin with populations of 100 or more, 42 communities need water systems or need expansion and improvement of existing systems, and 63 need sewerage systems. The costs for these developments are shown in Table IX-7.

TABLE IX-7. ESTIMATED COSTS FOR RECOMMENDED WATER AND SEWERAGE DEVELOPMENT, UPPER RIO GRANDE BASIN, NEW MEXICO (BY TIME PERIOD)

Year	Total Water and Sewerage Development (new and expansion) ($1,000's)	Federal Cost-Share Potential ($1,000's)	Total Cost to Local People ($1,000's)
1970	57,733	5,877	51,455
1980	74,494	2,368	72,126
2000	114,819	2,362	112,456
2020	157,135	2,905	154,229

Recommended actions for these communities to obtain financial and other assistance are:

1. Incorporate or organize into an association, if needed, to become a legal entity.

2. Seek assistance and guidance from (a) State Planning Office, (b) Councils of Government, (c) Environmental Improvement Agency, and (d) Farmers Home Administration.
3. Seek other sources of assistance for grants and loans. If small communities in the basin grow as projected, there will be a need for continual improvement and expansion of water and sewerage systems.

SOLID WASTE MANAGEMENT

The Department of Agriculture can assist the Environmental Improvement Agency, the State Planning Office, State Planning Districts, Councils of Government, municipalities, counties, and other legal organizations with the solid waste disposal problem as follows:

1. Location of disposal sites on soils that preclude possibility of groundwater or surface water pollution.
2. Assist in development of standards and recommendations for satisfactory operations of sanitary landfill facilities.
3. Design and construction of facilities.
4. Loan and grant funds for acquisition of waste disposal sites, garbage trucks, and sanitary landfill facilities.
5. Special use permits for sites on federal land (Forest Service).

TABLE IX-8. ESTIMATED COSTS FOR RECOMMENDED SOLID WASTE DISPOSAL, UPPER RIO GRANDE BASIN, NEW MEXICO

Year	Households Needing Service (No.)	Cost for Sanitary Landfill ($1,000/year) 1/
1970	107,900 2/	3,418
1980	194,814	4,676
2000	341,526	8,197
2020	550,588	13,213

1/ River Basin Field Party estimate
2/ Households needing sanitary landfill in 1970
Note: 1980-2020 assumption made that existing disposal systems (1970) would be depleted and disposal systems would be needed for all households.

RURAL ELECTRIFICATION

It is recommended that local groups and interests make more use of the assistance available through Rural Electrification Administrative loans. These loans enable members to purchase and install wiring, electrical, and plumbing equipment.

IMPACTS OF RECOMMENDED PROJECTS

The impacts of the recommended developments are described in this section. Quantitative impacts are given where possible. Many of the impacts can be described only in a qualitative manner, i.e., beneficial, adverse, or no impact. Table IX-15, pages IX-34 and 35, is included to indicate some of these impacts. No attempt is made to indicate the importance of one impact relative to another. The importance in many cases would vary dependent on the person making the evaluation.

PHYSICAL EFFECTS (EARLY ACTION PERIOD NEXT 10-15 YEARS)

The installation of the structural measures for watershed protection, flood prevention, and the land treatment systems during the Early Action Period would have measurable physical impacts on the water and related land resources in the basin. Impacts that would result from the recommended land treatment program include increased water yield, reduction in sediment deposition, increased forage yields, reduction of soil nutrient losses, and increased crop production.

There are 19 potential PL-566 watersheds recommended for inclusion in the Early Action Period. Impacts from these projects are:

1. Approximately 49,860 acres in the floodplains and damage areas would be protected from serious flood damage by the combination of structural control and land treatment. Of the floodplains, about 12,360 acres are in urban property and roads. The remaining 37,500 acres are primarily irrigated land and associated farmsteads.
2. Watershed projects would reduce average annual damage by about 89 percent on the 19 watersheds.
3. Structural measures would reduce sediment deposition in the damage areas by an estimated 369 acre-feet annually over the expected lifetime of the projects.
4. The quality of water from the treated watersheds would be improved. The amount of sediment carried downstream into storage reservoirs and irrigation systems would be reduced. The fish and wildlife habitat would be improved.
5. The estimated average annual groundwater recharge would be 7,300 acre-feet from the four watershed projects in the Estancia Valley.

Application of needed land treatment on about 3,036,000 acres of land in the basin would provide significant physical impacts such as:

1. Estimated average annual water yields and/or water savings would amount to about 13,300 acre-feet from improvement of irrigation systems.
2. Sediment deposition in the floodplain or damage areas would be reduced by about 529 acre-feet annually.
3. Soil nutrients of plant food removed by the erosion of 1,393,400 tons of soil annually would be saved.
4. Forage yields would be increased by an estimated 170,000 tons annually.
5. Increased crop production from improved irrigation systems and increased efficiencies in management of land and water.
6. Timber stand improvement and cultural treatment done on an annual average of 10,000 acres and 1,500 acres respectively for increasing the increment of the stands.

ECONOMIC EFFECTS (EARLY ACTION PERIOD)

Early Action projects assisted by the Department of Agriculture would help stabilize the basin economy. These programs and projects would enhance the economy of the basin by more efficient use of water and related resources. Efficiencies in the use of irrigation water could be increased by as much as 25 percent, which would help increase crop production and decrease fertilizer application, soil erosion, and the cost of crop production.

Estimated average annual flood damage reduction benefits from the installation of structural measures (PL-566) are $2,230,000. In addition,

average annual benefits of groundwater recharge in the Estancia Valley portion of the basin are an estimated $234,100. Installation, operation, and maintenance of these projects would provide about 128 man-years of employment annually with an estimated average annual value of about $574,000. Secondary benefits resulting from project works of improvement would amount to about $247,000 annually.

The recommended land treatment is estimated to have an average annual cost of nearly $3 million and average annual benefits of about $5.5 million. By 1980 the recommended projects and programs would increase crop production by $1,573,000 and production of red meat by $991,000.

From stumpage alone, the timber industry would have an estimated annual increase of $75,000. The cultural projects and timber stand improvement will provide an estimated 700 working days annually.

The primary economic impacts will create secondary economic impacts throughout the economy. Secondary impacts are caused by processing, transporting, and selling the additional or primary outputs, which in turn creates other smaller economic waves. As a result of increasing farm output by $2,338,000, secondary output impacts of $439,000 would be generated.

Through land treatment measures it is estimated that increased water yield and savings will amount to an average of 18,700 acre-feet per year. If this water is valued at $35 per acre-foot for agriculture, it would have a value of $644,500 per year. Sediment damage reduction benefits are estimated to be $597,000 and the value of soil nutrients lost would be reduced by $1,393,000 annually. Increased forage production will amount to $1,530,000 annually. Increased crop production by improved efficiencies in the use of land and water resources will amount to about $1,351,000 from land treatment. Added employment will amount to $414,000 per year and would provide an estimated 92 man-years of added employment.

PHYSICAL EFFECTS (AFTER EARLY ACTION PERIOD TO YEAR 2020)

Application of recommended land treatment still needed after Early Action period would provide significant physical impacts such as:

1. Water savings or increased yields estimated at 244,600 acre-feet annually.
2. Sediment deposition in the floodplain or damage area would be reduced by about 805 acre-feet annually.
3. Save the loss of soil nutrients in 3,129,700 tons of soil per year.
4. Increase forage production by 537,500 tons annually.

ECONOMIC EFFECTS (AFTER EARLY ACTION PERIOD)

Over nine million acres are recommended for some type of land treatment during the remaining period. About two-thirds of this program is

directed toward land treatment systems 1 and 2--good range management and pinyon-juniper management. Average annual costs for land treatment for the remaining period is $9.4 million returning average annual benefits of $20.6 million. Total cost is estimated in excess of $101 million.

The land treatment plan recommended for the basin is estimated by the River Basin Field Party to increase basin output of agricultural products as follows:

	1980	2000	2020
Livestock (Red Meat)	$ 991,000	$2,192,000	$ 5,375,000
Food Grains and Field Crops	1,175,000	2,938,000	4,488,000
Other Agriculture, fruits, vegetables, etc.	347,000	664,000	1,035,000
TOTAL	2,513,000	5,794,000	10,898,000

Red meat production increases are estimated to have benefits of over $5 million in 2020. Secondary output brought on by the program in 2020 is estimated at $2,314,000.

Water yield increase and salvage from land treatment during the period is estimated at 244,600 acre-feet per year. At $35 per acre-foot value, if used for irrigation in the basin, it would be worth nearly $8.6 million. If used for recreation, the water would have a value of $250 per acre-foot. Sediment damage reduction benefits are estimated to be about $900,000 and soil nutrient loss reduction benefits are estimated at about $3 million.

Increased crop production from the recommended program is estimated to be nearly $6 million annually during the period. Crop production would be stabilized by improving irrigation systems. More stable agricultural production may make it easier to establish marketing cooperatives and may tend to stabilize the rural non-farm economy in parts of the basin.

The lumber and wood products industries are expected to have more of a variety or products. Intensive timber management trends and national demands for products is likely to require a higher degree of utilization. The annual production is estimated to increase to $197,000 by 2000 and $261,000 by 2020 (Forest Service estimates based on projections).

INCOME AND EMPLOYMENT (1970-2020)

During the evaluation period for the plan (1970-2020) it is estimated that about 396 man-years of employment annually would be required to carry out the land treatment and structural measures. Primary wages created are estimated at over a million dollars.

To produce, process, and market the increased farm output in 1980, 133 man-years of employment would be required. Most of the employment will be in agriculture, requiring farm managers or proprietors. The remainder of the employment would call for semi-skilled or unskilled labor. Non-farm jobs call for mostly skilled and semi-skilled labor (see Table IX-10, page IX-27).

At the end of the remaining period over 500 man-years of employment would be needed to produce, process, and market the additional output. Table IX-11, page IX-28, shows these estimated employment impacts.

The employment opportunities may create a 3 percent increase over projected OBERS employment in 1980 and a similar increase by 2020. This increase could easily be drowned out by the present trend toward fewer and larger farms, and the increasing substitution of farm machinery for farm labor. The employment and wage changes are insignificant when compared to projections for the total basin economy.

TABLE IX-10. EMPLOYMENT-OCCUPATION IMPACTS DUE TO RECOMMENDED PROGRAM 1980 (EARLY ACTION), UPPER RIO GRANDE BASIN, NEW MEXICO

	Employment Change	Skill Level Required		
		Skilled	Semi-Skilled	Unskilled
Agriculture	109	58	5	46
Mining	0	-	-	-
Construction	0	-	-	-
Manufacturing	1	-	1	-
T. C. & U. 1/	1	-	1	-
Trade	14	4	7	3
F. I. R. E. 2/	3	1	2	-
Services	5	3	1	1
TOTAL	133	66	17	50

1/ T. C. & U. - Transportation, Communication, and Utilities
2/ F. I. R. E. - Finance, Insurance, and Real Estate
Source: Estimated via I-O model

TABLE IX-11. EMPLOYMENT-OCCUPATION IMPACTS DUE TO RECOMMENDED PROGRAM (AFTER EARLY ACTION) 2020, UPPER RIO GRANDE BASIN, NEW MEXICO

	Employment	Skill Level Required		
	Change	Skilled	Semi-Skilled	Unskilled
Agriculture	453	242	23	188
Mining	0	0	-	-
Construction	0	0	-	-
Manufacturing	8	4	4	0
T. C. & U. 1/	3	1	2	-
Trade	25	7	13	5
F. I R. E. 2/	7	3	4	-
Services	19	10	3	6
TOTAL	515	267	49	199

1/ T. C. & U. - Transportation, Communication, and Utilities
2/ F. I. R. E. - Finance, Insurance, and Real Estate
Source: Estimated via I-O model and occupation matrix

The greatest demand is for skilled workers. Unskilled rank second and semi-skilled last. In the non-farm areas, almost all of the needs are for skilled and semi-skilled workers. Wages created in producing, processing, and marketing increased farm output are estimated at $711,000 in 1980 and over $3 million in 2020. Most of these wages will accrue to farm people.

Table IX-12 summarizes the economic impacts of the recommended land treatment program for the basin. Early Action impacts are shown for 1980 and the remaining period impacts are summarized and shown for 2020.

Income and employment impacts from the Department of Agriculture proposals will differ depending upon the proposals accepted as feasible. Income will be increased substantially by greater efficiency in use of irrigation water, and increased production from alternative crops such as reseeded pastures, vegetable crops such as chili, sweet corn, tomatoes, and lettuce. Vegetable production would enhance economic returns to producers and would add seasonal employment opportunities for a limited number of local people.

TABLE IX-12. ECONOMIC IMPACTS OF RECOMMENDED LAND TREATMENT PROGRAM, 1980 and 2020, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

	1980	2020
Returns - average annual	$5,562,100	$20,634,500
Costs - average annual	2,922,400	9,392,200
Agricultural production increase	2,513,000	11,054,000
Forestry production increase	150,000	261,000
Secondary benefits	439,000	2,314,000
Wages		
program installation	414,000	792,000
program, marketing, etc.	711,000	3,796,000
Total wages	1,125,000	4,588,000
Employment (man-years)		
program installation	92 2/	176 2/
production, marketing, etc.	133 3/	515 3/
Total employment	225	691

1/ Increases due to recommended land treatment program
2/ See Table IX-4, page IX-14; see Table IX-5, page IX-15
3/ See Table IX-10, page IX-27; see Table IX-11, page IX-28

EFFECT OF RECOMMENDED PROGRAM ON WATER SUPPLY

Without the recommended program the existing water supply available for beneficial use would be reduced by 8,600 acre-feet in 1980; 32,200 acre-feet in 2000; and 55,000 acre-feet in 2020 due to the increased use of bottomland vegetation. The recommended program would make available 12,000 acre-feet in 1980; 55,200 acre-feet in 2000; and 215,600 acre-feet in 2020 to supply some of the projected needs. See Table IX-14, page IX-31, for effects on water supply "with" and "without" the recommended program.

TABLE IX-13. SUMMARY OF COSTS, BENEFITS, AND RETURNS FROM RECOMMENDED PROGRAM, UPPER RIO GRANDE BASIN, NEW MEXICO

Program or Project	Estimated Cost of Installation $ 1/	Average Annual Cost $ 2/	(Primary Impacts) Average Annual Benefit/Return $
1. Flood Prevention -19 Watershed Projects (PL-566)	46,698,000	2,699,300	3,347,000
2. Land Treatment Systems 3/	135,960,200	12,314,600	26,196,600
3. Community Water and Sewerage Systems	157,135,000	9,832,000	9,832,000 4/
4. Single-Purpose Recreation Reservoirs (19 sites)	4,750,000	306,700	306,700 4/
TOTAL	341,755,700	24,469,100	39,682,300

1/ 1969 costs.
2/ Amortized costs of installation plus estimated operation and maintenance costs.
3/ Includes land treatment systems shown in Table IX-5, page IX-15, and Table IX-6, page IX-16.
4/ USDA field party estimated benefits will equal costs.

The recommended program would prevent additional depletion by phreatophytes, increase water yields from watersheds, and salvage water that is now being non-beneficially depleted. The total annual effect of the program on the water supply would amount to the water added to the existing supply plus the increased depletions by bottomland vegetation as follows:

TABLE IX-14. EFFECTS ON WATER SUPPLY AND DEPLETIONS "WITH" AND "WITHOUT" RECOMMENDED PROGRAM, RIO GRANDE BASIN, NEW MEXICO

	1980		2000		2020	
	With Program (AcFt)	Without Program (AcFt)	With Program (AcFt)	Without Program (AcFt)	With Program (AcFt)	Without Program (AcFt)
Bottomland 1/	- 8,600	- 8,600	4,200	-32,200	91,800	-55,000
Increased Irrigation Efficiency 3/	13,300	0	28,300	0	42,400	0
Watershed Management	0	0	15,400	0	74,100	0
Flood Prevention 2/	7,300	0	7,300	0	7,300	0
Net Effect	12,000	- 8,600	55,200	-32,200	215,600	-55,000

1/ Effects of bottomland vegetation on surface water supply for beneficial use in the Rio Grande and tributaries.
2/ Increased recharge of ground water in Estancia subbasin.
3/ Based on 65 percent overall efficiency which may never be accomplished in total basin.

Figure IX-3, page IX-34, shows the estimated water supply for the basin "with" and "without" the recommended program. It also shows water requirements for the three projections. The water supply "without" the recommended program includes the effects of the San Juan-Chama Diversion Project, natural increase in depletion by bottomland vegetation, and the expected increase in the use of water in the Estancia groundwater basin (see Bar #1). Bar #2 shows the estimated water supply with the recommended program and includes the San Juan-Chama Diversion Project and the expected increase of water use in the Estancia subbasin.

ENVIRONMENTAL EFFECTS

The recommended programs will have beneficial and detrimental effects on the environment. The following display quantifies the overall effects in four areas of consideration: Natural Beauty; Water, Land, Air, and Human Resources; Biological Resources and Selected Ecosystems; and Irreversible or Irretrievable Commitments. In addition to the display, Table IX-15 presents a subjective analysis of effects of proposed programs on a variety of areas that may be affected.

A. Natural Beauty:

1. Nineteen potential watershed projects will inflict upon the landscape 115 structure sites (floodwater retardation sites and diversion channels) which will affect the natural appearance of the watershed.

2. Land treatment program on 12,000,000 acres of land needing special management will provide vegetative cover that will add color, protect the land from erosion, and increase wildlife forage supplies.

B. Quality Considerations of Water, Land, Air, and Human Resources:

1. Nineteen potential watershed projects will provide:

   a. Flood protection for 37,500 acres of cropland.

   b. Flood protection for 12,360 acres of urbanland.

   c. Flood protection for 7,577 homes, businesses, and farm improvements.

   d. Floodwater storage of 132,854 acre feet.

   e. Sediment storage of 31,984 acre feet.

   f. Upstream land treatment on 2,776,000 acres of watershed lands.

   g. Improved irrigation water management practices on 56,244 acres of cropland.

   h. Employment of 140 man-years for twenty-five years.

2. Land treatment program (early action - next 10-15 years) on 3,035,800 acres will create annual opportunities for:

   a. Increased water yield of 18,700 acre feet.

   b. Sediment reduction of 529 acre feet.

   c. Soil loss reduction of 1,393,400 tons.

   d. Increased forage yields of 170,000 tons.

   e. Ninety-two man-years employment.

3. Land treatment program (after the early action period to year 2020) on 9,117,800 acres will create annual opportunities for:

   a. Increased water yield of 242,600 acre feet.

   b. Sediment reduction of 805 acre feet.

   c. Soil loss reduction of 3,129,700 tons.

d. Increased forage yields of 537,500 tons.

e. Increase of 176 man-years employment.

4. Forest land programs include:

   a. Increased fire protection for 717,000 acres of state and private commercial timberland and 314,000 acres of national forest land.

   b. Recreation development of 31,658 family unit sites on national forest land.

   c. Two thousand miles of fencing in national forests for better forage utilization.

5. Water pollution and health hazards will be minimized by the installation of 42 community water supply systems and 63 community sewerage systems.

C. Biological Resources and Selected Ecosystems:

1. The potential land treatment program will increase forage yields by more than 700,000 tons per year. Much of this forage will be utilized by wildlife for food and cover.

2. Flood protection structures will minimize sediment pollution in approximately 1,000 miles of fishing streams.

3. National forest programs include:

   a. Fish habitat improvement on 406 miles of stream and 119 acres of lakes.

   b. Developing 69 wildlife watering facilities.

   c. Developing 977 range watering facilities that will benefit wildlife.

D. Irreversible or Irretrievable Commitments:

Nineteen potential watershed projects will require 115 structure sites. If all sites were constructed, 11,600 acres of land will be required for structure site areas and flood pools.

LEGEND:
- \- Adverse Impact
- 0 No Impact
- X Beneficial Impact

POSSIBLE EFFECTS	LAND TREATMENT SYSTEMS: SNOWPACK MANAGEMENT (1)	(2)	BRUSH MANAGEMENT (1)	(2)	SPRUCE-FIR MANAGEMENT (1)	(2)	PONDEROSA-PINE MANAGEMENT (1)	(2)	PINYON-JUNIPER MANAGEMENT (1)	(2)	ASPEN MANAGEMENT (1)	(2)	PHREATOPHYTE CONTROL (1)	(2)	BOTTOMLAND MANAGEMENT (1)	(2)	DRAINAGE (1)	(2)	IMPROVED IRRIGATION SYSTEMS (1)	(2)	ABANDONED CROPLAND MANAGEMENT (1)	(2)	CRITICAL EROSION MANAGEMENT (1)	(2)	STRUCT: FLOODWA & OTH PURPOS RESERVO (1)
VISUAL																									
1. Open Pits, Construction Machinery, Roads	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	0	0	0	0	-	X	-
2. Scenic views visible from travel routes	-	-	-	X	-	-	-	X	-	0	-	X	-	-	0	0	-	X	-	X	-	X	-	X	-
3. Turbidity of water in creeks, rivers, lakes, etc.	-	X	-	X	-	0	-	0	-	X	-	0	-	X	0	X	-	0	0	X	-	X	-	X	0
4. Erosion scars	-	0	0	X	-	-	-	0	0	0	-	0	-	0	-	X	-	X	X	X	X	X	-	X	0
5. Wildlife (deer, rabbits, etc.)	-	0	0	X	X	X	X	X	-	X	X	X	-	X	-	X	-	X	0	X	-	X	-	X	0
6. Fish	-	X	0	X	-	X	-	X	0	0	-	X	-	X	-	X	0	X	0	X	-	X	-	X	0
7. Maintain natural lake levels	0	X	0	0	X	X	X	X	0	0	X	X	0	X	0	0	0	0	0	0	-	X	-	X	0
8. Maintain natural stream flow	0	X	0	X	X	X	X	X	0	X	X	X	0	X	0	0	-	-	0	X	-	X	-	X	0
9. Road and trail damage to streams, lakes, etc.	-	0	-	0	-	-	-	-	-	0	-	-	0	0	0	0	-	0	0	0	0	0	0	0	-
10. Fire hazard and control	0	0	0	X	-	-	-	X	0	X	-	X	0	0	0	0	0	0	0	0	0	0	0	0	0
11. Man-made objects (not natural to the environment)	-	-	0	0	-	-	-	-	0	0	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-
12. Visibility reduced due to wind erosion	0	0	-	0	-	0	-	0	-	X	-	0	0	0	X	X	0	0	0	X	-	X	-	X	0
HUMAN USE AND INTEREST																									
1. Historical features	0	0	0	0	-	-	-	X	0	0	-	X	0	0	0	0	0	0	0	0	0	X	-	X	-
2. Archeological features	0	0	0	0	0	0	-	X	0	0	-	X	0	0	0	0	0	0	0	0	0	X	-	X	-
3. Geological features	0	0	0	0	-	X	-	X	0	0	-	X	0	0	0	0	0	0	0	0	0	-	-	-	-
4. Scenic features and natural beauty	-	-	-	-	-	-	-	X	-	X	-	X	-	X	-	X	-	0	0	X	-	X	-	X	-
5. Public Safety	0	0	0	0	-	-	-	X	0	0	-	X	0	X	0	X	0	X	X	X	-	X	-	X	0
6. Economic returns	-	X	-	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	X	-	X	0
7. Health	0	X	-	X	0	0	0	0	0	0	0	0	0	0	X	X	X	X	X	X	-	X	-	X	0
8. Noise	0	0	0	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	-	0	-
9. Attractive hazard	0	0	0	0	-	0	-	0	0	0	-	0	0	0	0	0	0	X	0	X	0	0	-	X	-
10. Standard of living	0	X	0	X	X	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	0	X	0	X	0
11. Stronger sense of community and participation	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BIOLOGICAL SYSTEMS																									
1. Open pits, machinery, etc., dangerous to wildlife	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	0	0	-	0	-	0	-
2. Forage needs for livestock	-	X	-	X	-	X	-	X	-	X	-	X	0	X	0	X	0	X	X	X	-	X	-	X	0
3. Trailing and other concentrations of livestock	-	-	0	0	-	0	-	0	0	X	-	0	0	X	0	X	0	X	0	0	-	0	-	0	-
4. Big game forage and habitat requirements	-	X	-	X	-	X	-	X	-	X	-	X	-	-	-	X	0	X	X	X	-	X	-	X	-
5. Fire hazard and control	0	0	0	X	-	-	-	X	-	0	-	X	0	X	0	0	0	0	0	0	0	0	-	0	0
6. Water contamination from herbicides, insecticides, and pesticides	0	X	-	0	-	0	-	0	-	0	-	0	-	0	0	0	0	0	0	0	0	X	0	X	0
7. Soil and forage contamination from herbicides, insecticides, and pesticides	0	0	-	0	-	0	-	0	0	0	-	0	-	0	0	0	0	0	0	0	0	0	0	0	0
8. Sediment pollution from erosion	-	0	-	X	-	0	-	0	0	X	-	0	0	0	0	X	-	0	0	X	0	X	-	X	-
9. Escape ramps for small animals and birds	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	-	-	0	0	0	0	0	0	-
10. On-sight water needs	0	0	0	0	-	X	-	X	0	0	-	X	-	X	0	0	0	X	X	X	0	0	0	X	0
11. Vegetation along streambanks for fish and wildlife	-	X	-	X	0	0	X	X	0	0	X	X	-	-	0	X	-	-	0	X	0	X	-	X	0
12. Maintain natural lake levels	0	X	0	X	-	0	-	0	0	X	-	0	0	X	0	X	-	-	0	X	0	0	-	X	0
13. Maintain natural stream flow	0	X	X	X	X	0	X	0	0	X	X	0	0	X	0	X	X	X	0	X	0	0	-	X	-
14. Water tables in meadows, along rivers, etc.	0	X	0	X	X	X	X	X	0	0	X	X	0	X	0	X	X	X	0	X	0	0	0	X	0
15. Wildlife movement and migration	-	-	-	-	-	X	-	X	-	X	-	X	0	-	0	X	-	X	0	0	-	X	0	X	0
16. Habitat of rare and endangered species	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	0	-	X	-	X	0	X	0
17. Access for game harvest	0	-	-	X	X	X	X	X	-	X	X	X	0	X	-	X	0	X	X	X	-	0	0	X	-
18. Cover for small game near feeding and watering areas	-	X	-	X	-	X	-	X	-	X	-	X	0	-	-	X	-	X	0	X	-	X	0	X	0
19. Protection of wildlife fawning, calving, kidding, and nesting areas	-	X	-	-	-	X	-	X	-	0	-	X	0	-	-	X	-	X	-	X	-	X	-	X	0
20. Phreatophyte control	0	-	X	X	0	0	0	0	0	X	0	0	0	X	X	X	X	X	X	X	0	0	0	0	0
21. Drainage	0	-	0	0	0	0	0	0	0	0	0	0	0	X	0	X	X	X	0	X	0	0	0	0	0
22. Stream channelization	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0
23. Micro-climate	0	X	-	-	-	-	-	X	-	X	-	X	0	X	X	X	X	X	0	X	-	X	-	X	-
24. Noise	0	0	0	0	-	0	-	0	-	0	-	0	0	0	0	0	0	0	-	0	-	0	-	0	-
25. Maintenance of habitat of plants and animals determined rare or in danger of extinction	0	-	-	-	-	-	-	X	-	-	-	X	-	-	0	X	0	0	0	X	-	X	-	X	-
LAND QUALITY																									
1. High value land	0	0	-	X	-	X	-	X	0	X	-	X	0	X	X	X	X	X	X	X	X	X	X	X	X
2. Spread of noxious plants	0	0	X	X	0	0	X	-	0	0	X	-	X	X	X	X	X	X	X	X	X	X	0	0	0
3. Forage for livestock	0	X	0	X	0	X	-	X	-	X	-	X	0	X	X	X	X	X	0	X	X	X	0	X	0
4. Major soil disturbances	-	0	-	X	-	X	-	X	-	X	-	X	-	X	-	0	-	0	0	X	-	X	-	X	-
5. Cross-country travel on critical soil areas	0	X	-	X	-	-	-	-	0	0	-	-	0	0	0	0	0	0	0	0	0'	0	0	X	0

Fire hazard	0	0	-	X	-	-	-	-	0	X	-	-	0	0	X	X	0	0	0	0	0	0	0	0	0	X	0	X
Fresh, litter to impair scenic beauty	0	-	-	-	-	-	-	-	-	-	-	-	0	0	X	X	X	X	0	X	0	0	0	0	-	-	-	0
Erosion	0	0	-	X	-	-	-	-	0	X	-	-	0	0	X	X	0	0	0	X	0	X	X	X	0	X	0	0
Sediment deposition	0	0	-	X	-	-	-	-	-	X	-	-	0	X	X	X	0	0	0	X	-	X	X	X	-	X	0	0
Insect and vegetation disease control	0	0	0	0	-	X	-	X	0	X	-	X	0	X	X	X	X	X	0	X	0	0	0	0	0	0	0	0
Soil contamination due to herbicides, insecticides, and pesticides	0	0	-	-	-	0	-	0	-	-	-	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soil disturbance	-	0	-	X	-	X	-	X	-	X	-	X	-	0	-	0	-	0	-	X	-	X	-	X	-	0	-	0
Floodwater damage	0	-	0	0	-	0	-	0	0	0	-	0	0	0	0	0	X	X	-	X	-	X	-	X	-	X	0	0
Enhance potential recreation sites and access thereto	0	X	0	0	-	X	-	X	-	X	-	X	0	X	X	X	X	X	0	X	-	X	X	X	-	X	0	0
Trailing and concentrations of livestock	0	0	0	0	0	-	-	-	-	X	-	-	0	X	X	X	X	X	0	0	0	0	0	X	-	-	0	0
Big game forage and habitat needs	-	-	-	X	-	X	-	X	-	X	-	X	0	X	X	X	0	X	0	X	-	X	0	X	-	-	-	-
Hydrologic function of the watershed	-	X	-	X	-	X	-	X	-	X	-	X	0	0	0	X	0	X	0	0	-	X	X	X	-	X	0	0
On-site water needs	-	X	0	0	X	X	X	X	0	0	X	X	0	X	X	X	0	X	0	X	0	0	0	0	0	X	0	X
Vegetation along streambanks for fish and wildlife	-	X	0	0	-	X	-	X	0	0	-	X	-	-	0	X	0	0	0	0	0	0	0	X	0	X	0	0
Streambank cutting reduced to loss	0	0	0	0	X	X	X	X	0	0	X	X	0	0	X	X	0	0	0	0	0	0	0	0	0	X	0	0
Water table in meadows, pastures, etc.	0	X	0	0	-	X	-	X	-	X	-	X	0	X	0	X	X	X	0	X	0	0	0	0	0	0	0	0
Protection from municipal watersheds	-	0	-	X	-	X	-	X	0	X	-	X	0	0	X	X	0	0	0	X	-	X	X	X	0	X	0	X
Phreatophyte control to change land use	0	0	0	0	0	0	-	X	0	0	0	0	X	X	X	X	X	X	0	X	0	0	0	0	0	X	0	0
Drainage	0	-	0	0	0	0	-	X	0	0	0	0	-	-	X	X	X	X	X	X	0	0	0	0	0	0	0	0
Stream channelization	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0
Wildlife movement and migration	0	-	-	X	-	X	-	X	-	X	-	X	0	X	0	X	-	X	0	0	0	0	-	X	-	-	-	-
Habitat of rare and endangered wildlife species	-	-	-	X	-	X	-	X	-	X	-	X	-	-	-	X	-	X	-	X	-	X	0	X	-	X	0	0
Access for game harvests	0	0	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0	X	0	0	0	X	-	-	-	-
Cover for small game feeding and watering	-	0	-	X	X	X	X	X	-	X	X	X	-	X	-	X	-	X	-	X	-	X	-	X	-	0	0	0
Protection of wildlife fawning, calving, kidding, and nesting	-	0	-	X	-	X	-	X	-	X	-	X	0	X	0	X	-	X	0	X	-	X	-	X	-	0	0	0
Nutrient loss due to erosion	0	0	0	0	-	-	-	-	-	X	-	-	0	0	0	X	0	0	0	X	0	X	-	X	0	0	0	0
Dirt roads and trails as source of erosion	0	0	0	0	0	0	0	0	0	0	-	-	0	0	0	X	0	0	0	0	0	X	0	0	-	0	-	0
Use of land within its carrying capacity	0	0	-	X	0	0	X	X	0	X	X	X	X	X	X	X	X	X	X	X	0	X	X	X	0	X	0	X
Correct past misuse of land	0	X	-	X	-	X	-	X	0	X	-	X	X	X	X	X	X	X	X	X	0	X	X	X	X	X	X	X
QUALITY																												
Sediment pollution	-	0	-	X	-	0	-	0	-	X	-	0	0	0	X	X	0	0	0	X	-	X	X	X	-	X	0	0
Dilution of pollution by increased yield	0	X	0	X	X	X	X	X	0	X	X	X	0	X	0	X	X	X	X	X	0	0	X	X	0	0	0	0
Phreatophyte control	0	-	0	X	0	0	-	X	0	0	0	0	X	X	X	X	X	X	X	X	0	0	0	0	0	X	0	0
Contamination due to herbicides, insecticides, and pesticides	0	0	-	-	-	0	-	0	0	0	-	0	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0
Nutrient pollution	0	0	0	0	-	0	-	0	0	0	-	0	0	X	0	X	0	0	X	X	-	X	0	X	0	X	0	X
Municipal use	0	X	0	X	-	X	-	X	0	X	-	X	0	X	-	X	0	X	0	0	-	X	0	X	0	X	0	X
Agricultural Use	0	X	0	X	-	X	-	X	0	X	-	X	0	X	-	X	0	X	0	0	-	X	0	X	0	X	0	0
Fish and wildlife use	0	X	0	X	-	X	-	X	0	X	-	X	0	X	0	X	-	-	0	X	0	X	0	X	0	-	0	X
Salinity due to erosion	0	X	0	X	0	0	-	0	0	X	0	0	0	0	0	X	0	0	0	X	0	X	X	X	0	0	0	0
Salinity due to return flows of irrigation water	0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X	0	0	0	X	0	0	0	0	0	0	0	0
Preservation of intrinsic values of flowing streams	0	X	0	X	-	X	-	X	0	0	-	X	0	X	0	X	X	X	0	X	0	X	0	X	0	X	0	0
IC																												
Employment	X	X	X	X	X	0	X	X	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Floodwater damage	0	-	0	0	-	-	-	-	0	0	-	-	0	0	0	X	0	0	0	0	0	X	0	X	0	X	0	0
Sediment damage	0	0	-	X	-	-	-	-	0	X	-	-	0	0	0	X	0	0	0	X	-	X	X	X	0	X	0	0
Erosion damage	0	0	-	X	-	-	-	-	0	X	-	-	0	0	0	X	0	0	0	X	-	X	X	X	0	X	0	0
Nutrient loss	0	0	0	X	-	-	-	-	0	X	-	-	0	X	0	X	0	0	0	X	-	X	0	X	0	0	0	0
Crop production	0	X	0	X	X	X	X	X	0	X	X	X	0	X	X	X	X	X	X	X	0	X	X	X	0	X	0	0
Forage for livestock	0	X	0	X	0	0	-	X	0	X	-	X	-	X	X	X	X	X	X	X	0	X	-	X	0	0	0	0
Income	0	X	0	X	X	X	X	X	0	X	X	X	0	X	X	X	X	X	X	X	0	X	0	X	X	X	X	X
Change in land use	0	0	0	0	-	X	-	X	0	0	-	X	X	X	X	X	X	X	X	X	0	X	0	X	0	X	0	0
Land value	0	0	0	X	-	X	-	X	0	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Income stabilization	X	X	0	X	X	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Employment stabilization	X	X	0	X	X	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OR RECREATION																												
Warm water fishing	0	X	0	X	0	0	0	0	0	0		0	0	X	0	0	0	0	0	X	0	0	0	X	0	X	0	0
Swimming	0	X	0	0	0	0	0	0	0	0		0	0	X	0	0	0	0	0	0	0	0	0	X	0	0	0	X
Picnicking	0	0	0	0	-	0	-	X	0	X		X	-	-	0	X	0	X	0	0	0	0	0	0	-	X	0	0
Hiking	0	0	0	0	-	0	-	X	0	X	-	X	-	-	0	X	0	X	0	0	-	X	0	0	-	-	-	-
Sightseeing	0	X	-	X	-	X	-	X	0	X	-	X	-	-	0	X	0	0	-	X	-	X	0	0	-	-	-	-
Small game hunting	0	0	-	X	-	X	-	X	-	X	-	X	-	X	-	X	0	X	-	X	-	X	0	X	-	-	-	-
Nature studies	0	0	-	-	-	-	-	-	-	-	-	X	-	-	0	0	-	-	-	X	-	X	0	0	-	X	-	0
Tent and trailer camping	0	0	-	X	-	0	-	X	0	X	-	X	-	-	-	X	-	X	0	0	0	0	0	0	-	X	0	0
Waterskiing	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	X	0	X	0	0
Scuba diving	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	X	0	0	0	0
Motorboating	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	X	0	0	0	0
Sailing	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	X	0	0	0	0
Canoeing	0	0	0	0	0	0	0	0	0	0	0	0	0	X	0	0	0	0	0	0	0	0	0	X	0	0	0	0
Bird and waterfowl hunting	0	X	0	X	-	X	-	X	-	X	-	X	-	-	-	X	-	-	-	X	0	X	0	X	0	X	0	0
Nature photography	0	X	0	X	-	X	-	X	0	-	-	X	-	-	-	X	-	-	0	X	0	X	0	X	-	-	-	-
Pack trips	0	X	0	0	-	X	-	X	0	0	-	X	-	-	0	0	0	X	0	0	0	0	0	0	-	-	0	0

- During installation; (2) - Post Installation

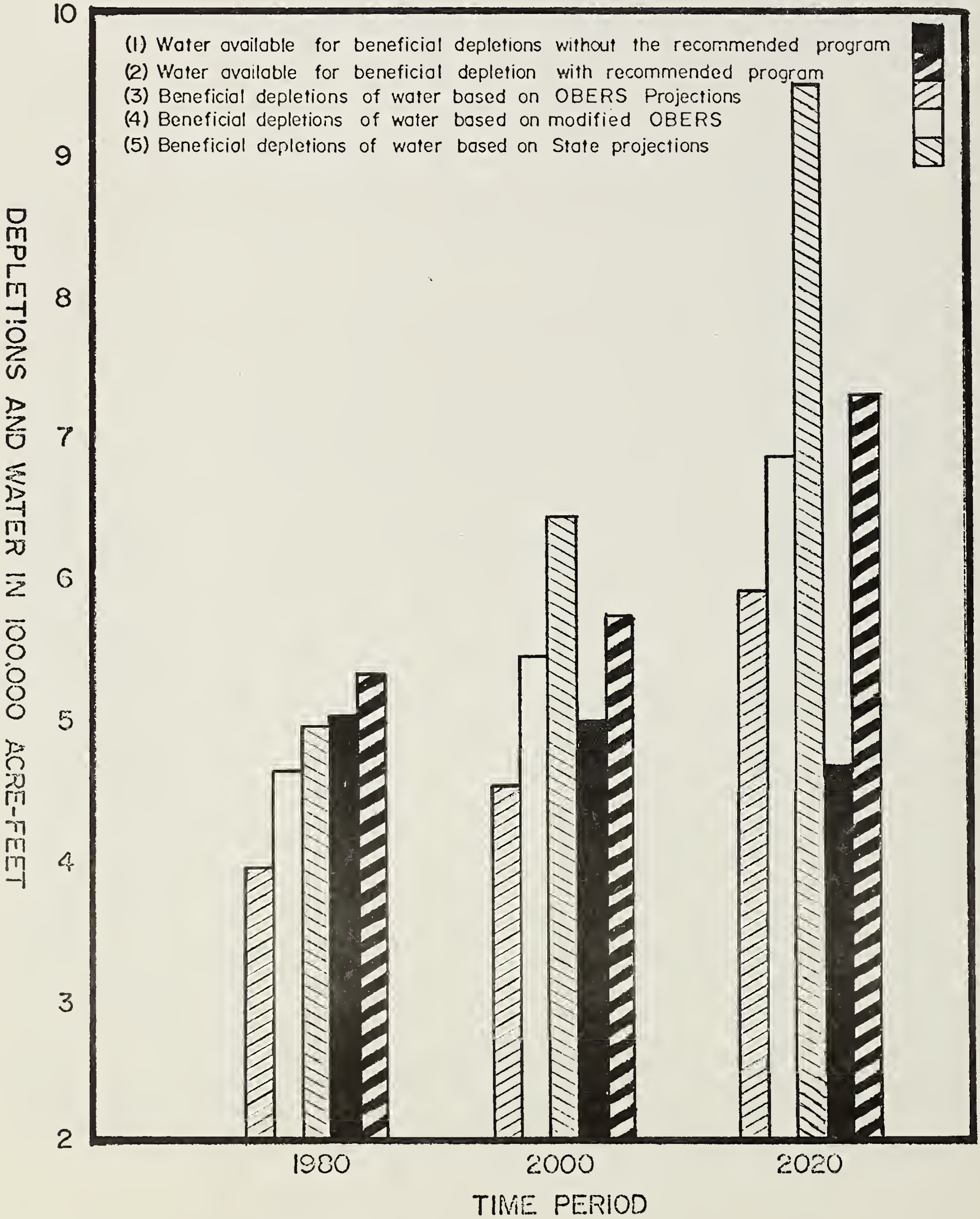


FIGURE IX-3. ESTIMATED SUPPLY AND WATER REQUIREMENTS

EVALUATION OF IMPACTS FROM LAND TREATMENT WITH ALTERNATIVE OBJECTIVES

Decision makers can make numerous analyses from the land treatment data. The objectives shown in Table IX-16 ignore the overall treatment needs of the land and are designed to emphasize a single purpose. The five treatments selected as most effective for any objective are also effective to varying degrees in achieving other objectives. For example, the treatment selected as giving the best monetary returns are almost as effective for water saving and increased water yield as are the treatments specifically selected for that purpose. Table IX-16 groups together combinations of five land treatment systems that best achieve the stated objectives.

The cost to society if they fail to initiate an accelerated land treatment program is identified in one area as the negative impact that will result by increased encroachment of undesirable vegetation. This evaluation was made on two areas, those occupied by phreatophytes and by pinyon-juniper. For phreatophyte areas needing treatment the amount of water used by phreatophytes was compared to the amount used by grass. The difference is an estimated 177,800 acre-feet of water annually by the year 2020. At the present estimated value of $35 an acre-foot, this represents a future annual loss to society of $4,473,000.

By the same year, competition will reduce forage yield by 20,600 tons annually, which is worth $92,700 for grazing livestock at current prices.

On pinyon-juniper areas undesirable tree and shrub-type vegetation is estimated to decrease forage yields over the area needing control by 32,887 tons, which has an estimated value for livestock grazing of $148,000.

TABLE IX-16. COSTS AND IMPACTS FROM LAND TREATMENT WITH EMPHASIS ON DIFFERENT OBJECTIVES

OBJECTIVE WITH SELECTED LAND TREATMENT SYSTEMS	ACRES TO BE TREATED	ESTIMATED COST OF TREATMENT $	AVERAGE ANNUAL COST 1/ $	AVERAGE ANNUAL RETURN $	COST RETURN RATIO	INCREASED WATER YIELD AND SAVINGS AC/FT/YR	SEDIMENT DAMAGE REDUCTION AC/FT/YR	INCREASED FORAGE YIELDS TONS/YR	EROSION REDUCTION (SOIL NUTRIENTS) TONS/YR	ADDITIONAL EMPLOYMENT MAN YRS/YR
1. MAXIMUM NET RETURN PER DOLLAR OF COST:										
Drainage	37,900	947,500	111,700	965,500	1:8.6	-	-	-	-	1
Phreatophyte Control	86,300	8,362,500	1,418,500	5,516,000	1:2.6	146,800	-	38,000	-	8
Improved Irrigation Systems	152,900	9,174,000	1,407,500	3,540,300	1:2.5	42,400	-	-	-	24
Sagebrush Control	83,800	670,400	59,100	260,700	1:4.4	-	9	21,000	69,200	2
Abandoned Cropland Management	117,200	1,758,000	145,300	631,100	1:4.3	-	4	58,600	30,200	4
TOTAL	403,300	20,912,400	3,142,100	10,913,600	1:3.4	189,600	13	117,600	99,400	39
2. INCREASED WATER YIELDS & SAVINGS										
Phreatophyte Control	86,300	8,362,500	1,418,500	5,516,000	1:2.6	146,800	-	38,000	-	8
Improved Irrigation Systems	152,900	9,174,000	1,407,500	3,540,300	1:2.5	42,400	-	-	-	24
Mixed Conifer Management	143,000	5,720,000	401,400	960,500	1:2.4	23,800	6	7,200	37,900	4
Ponderosa Pine Management	391,000	11,730,000	823,200	905,000	1:1.1	16,300	17	19,600	103,000	8
Pinyon-Juniper Management	2,409,100	9,636,400	796,500	2,829,800	1:3.6	20,000	133	121,000	843,800	21
TOTAL	3,207,500	44,622,900	4,847,100	13,751,600	1:2.8	249,300	156	185,800	984,700	65
3. IMPROVEMENT OF WATER QUALITY BY REDUCTION OF EROSION:										
Critical Erosion Area Treatment	2,357,600	35,364,000	2,932,600	5,079,000	1:1.7	-	892	118,000	1,828,000	79
Range Management	4,957,800	27,268,000	2,411,700	3,998,000	1:1.7	-	205	248,000	1,268,000	76
Pinyon-Juniper Management	2,409,100	9,636,400	796,500	2,829,800	1:3.6	20,000	133	121,000	299,500	21
Ponderosa-Pine Management	391,000	11,730,000	823,200	905,000	1:1.1	16,300	17	19,600	103,000	8
Pinyon-Juniper Control	877,000	13,155,000	1,082,700	1,078,300	1:1.0	7,300	27	44,000	170,900	26
TOTAL	10,992,500	97,153,400	8,046,700	13,890,100	1:1.7	43,600	1,274	550,600	3,669,400	210
4. INCREASED EMPLOYMENT:										
Range Management	4,957,800	27,268,000	2,411,700	3,998,000	1:1.7	-	205	248,000	1,268,000	76
Pinyon-Juniper Management	2,409,100	9,636,400	796,500	2,829,800	1:3.6	20,000	133	121,000	1,085,600	21
Pinyon-Juniper Control	877,000	13,155,000	1,082,700	1,078,300	1:1.0	7,300	27	44,000	170,900	26
Improved Irrigation Systems	152,900	9,174,000	1,407,500	3,540,300	1:2.5	42,400	-	-	-	24
Critical Erosion Area Treatment	2,357,600	35,364,000	2,932,600	5,079,000	1:1.7	-	892	118,000	1,828,000	79
TOTAL	10,754,400	94,579,400	8,631,000	16,525,400	1:1.9	69,700	1,257	531,000	4,352,500	226
5. INCREASED FORAGE YIELD:										
Range Management	4,957,800	27,268,000	2,411,700	3,998,000	1:1.7	-	205	248,000	1,268,000	76
Pinyon-Juniper Management	2,409,100	9,636,400	796,500	2,829,800	1:3.6	20,000	133	121,000	299,500	21
Critical Erosion Area Treatment	2,357,600	35,364,000	2,932,600	5,079,000	1:1.7	-	892	118,000	1,828,000	79
Abandoned Cropland Management	117,200	1,758,000	145,300	631,100	1:4.3	-	4	58,600	30,200	4
Phreatophyte Control	86,300	8,362,500	1,418,500	5,516,000	1:2.6	146,800	-	38,000	-	8
TOTAL	9,953,200	82,388,900	7,704,600	18,053,900	1:2.3	166,800	1,234	583,600	3,425,700	188

1/ Includes amortized cost of treatment plus estimated average annual operation and maintenance cost.

WATER USE ANALYSIS

This analysis is made to demonstrate the relative impacts that three different water use patterns could have on monetary output and employment. Before proceeding further a warning about assumption number one below is necessary. Assumption number one implies that if additional water were to become available, the basin's economy would respond by expanding. Such a relation is not likely in the real world. Economies do not necessarily expand upon an infusion of water. Market outlets, trained workers, favorably priced inputs, reasonable taxes, etc., all combine with water to bring on economic expansion.

An average annual increase of 244,300 acre-feet in the water supply has been run through the input-output matrix in three different use patterns along with employment coefficients to find the effect on basin output and employment. The water yield increase is first assumed to be used only in agriculture, then only in industry, transportation, communication and utilities, and then spread throughout the basin economy in all sectors.

The assumptions necessary are:

1. Water is the only restraint to further output in the basin. Capital and labor are unlimited (see caution concerning the assumption).
2. 244,300 additional acre-feet of water per year represent a relief of the basin water restraint.
3. All 244,300 acre-feet are utilized in the basin.
4. Water depletion and employment coefficients are realistic.

Results of the analysis are shown in Table IX-17, page IX-40.

Clearly, if the basin goal is to increase output and employment via water use, then industrial application offers the greatest potential. Side effects such as additional pollution would probably result. Using additional water throughout the economy represents the most likely alternative.

The output and employment impacts are considerably less than those brought on by industrial use in this experiment. Agricultural use of additional water creates the smallest estimated impact. The agricultural use alternative impacts indicate a one percent increase over OBERS output projections and a one percent increase over OBERS employment projections. The industrial alternative shows a 203 percent increase in output and an 80 percent increase in basin employment. Using water throughout the economy increases output 64 percent over OBERS and employment 38 percent over OBERS level projections.

TABLE IX-17. ECONOMIC EFFECTS OF ALTERNATIVE WATER USE, UPPER RIO GRANDE BASIN, NEW MEXICO, 2020 1/

Water Use	Increased Gross Basin Output Thous. $	Increased Basin Employment
Agriculture	138,237	5,550
Industry, TCU	31,371,333	415,900
All Sectors of Economy	9,815,983	199,700

1/ Estimated using 2020 I-O model data

CHAPTER X

Coordination and Programs For Further Development

Some of the potential developments are not now feasible or applicable under existing USDA programs, and for others water is not available. Some of the existing and projected needs may be met by other authorities, but some will require new legislation and authority for development. Also, there may be alternative methods for solving some of the problems. Resource Conservation and Development Committees, Four-Corners Development Commission, and area planning organizations such as the councils of government, can coordinate and put into action some of the projects and programs that will help to meet some of the basic needs. Some of the conservation practices involve private lands and new authorities may be needed if they are to be accomplished.

ALTERNATIVE APPROACHES

FLOOD INSURANCE

Incorporated communities for which protection cannot be justified through Public Law 566 or other federal programs might qualify for flood insurance offered by the U.S. Department of Housing and Urban Development.

Communities that might consider this alternative are: Taos, San Ysidro, Pilar, Placitas, Zia Pueblo, Santo Domingo Pueblo, Cochiti Pueblo, San Felipe Pueblo, Santa Ana Pueblo, Abiquiu, Cebolla, Canjilon, Vallecitos, Ojo Caliente, Chamita, Santa Clara Pueblo, Tijeras, Moriarity, Isleta Pueblo, Chilili, Tajique, Mountainair, La Joya, Monticello, and Cuchillo. Communities that are not incorporated may seek incorporation or have the eligible county apply for flood insurance. Information on flood insurance can be obtained by contacting "Flood Insurance Administration, Washington, D.C.".

WATER IMPORTATION

Water is not available for the development of all potential projects in the basin. If potentials are fully developed, water would have to be imported. There are eight million acres of additional land in the basin with soils and topography suitable for irrigation that would require about 20 million acre-feet of water annually.

Nineteen potential sites for single purpose recreation reservoirs are located in the basin with an estimated water depletion of about 3,500 acre-feet per year. Part of these requirements could be supplied from water imported by the San Juan-Chama Project and some by retiring existing water rights, but the remainder would have to be imported.

WEATHER MODIFICATION

Weather modification may offer possibilities of increasing the amount of water. There are numerous weather modification studies in progress in the western United States conducted by the federal government and private companies. These studies include the application of silver iodine to clouds from planes and by ground-based generators, dusting clouds with dry ice (carbon dioxide), and spraying water into clouds from airplanes. Some states have enacted laws in an attempt to regulate weather modification practices. Experiments have proven for certain conditions, in some localities, precipitation can be increased by 20 percent by seeding clouds with silver iodine. These conditions may not be favorable for increasing precipitation in other localities; therefore, experimental results obtained to date should be used with caution.

PUMP IRRIGATION

An alternative in some areas of irrigated bottomland in the basin is to change from surface to ground water irrigation. This practice would assure a water supply when needed and permit farmers to better plan operations to grow a wider variety of crops. This method of irrigation would use less water and discourage "over irrigation", minimizing erosion and leaching nutrients from the soil. Many ditch facilities could be abandoned, reducing system maintenance and making phreatophyte control easier. Stream pollution by refuse and chemicals carried in tail water could be minimized.

This program is an alternative to part of the water management proposals in the previous section. A change such as this would require conformance with statutes governing the appropriation and use of public water and compliance with the rules and regulations of the New Mexico State Engineer.

WATER RIGHTS SALE

An economic alternative to the present use of water in the basin is to sell water rights for uses that produce higher returns. Any change in the place or purpose of use would have to comply with the statutes governing the appropriation and use of public waters and conform with the rules and regulations of the State Engineer. Due to social or cultural pressures, this alternative may not be acceptable although economically sound.

RANGE BANK PROJECT

An alternative approach to rangeland protection would be a program similar to the "soil bank" program of several years ago. A "range bank" approach would differ in that rangelands would be retired for a period of years until vegetation could be re-established and erosion and sediment control facilities could be installed. This would be a program that could be extended indefinitely for rangelands where grazing was not in the best interest of the public. This would be especially applicable on some critical sediment source areas.

BADLAND RECREATION

Many thousands of acres of badlands (areas of geologic erosion with little or no plant cover) and numerous historical sites are present in the basin. Some of these could be developed for scenic recreation with overnight camping facilities that could compliment water-based recreation. These developments could be added to the state park facilities or be developed by counties or municipal park authority. These highly erosive areas can then be protected from other uses.

LIVESTOCK INDUSTRY DEVELOPMENTS

Analysis shows that the annual production of saleable livestock (116,200 calves and 19,900 grown animals) on non-irrigated grazing land is eight times the number slaughtered. Further study is warranted of the opportunity for livestock feeding, processing, and packing plants in the basin.

LAND USE LEGISLATION

There is a need for legislation to permit county-wide and state-wide land use planning. Land use plans need to be developed to cope with future population and economic expansion in the area. Responsibility for this type project lies with county, municipal, state, and federal planners. Zoning should be based on consideration of soils, topography, flood hazard, etc.

The rapidly growing areas of Albuquerque, Santa Fe, and Espanola have an immediate need for long range land use planning and zoning. The Estancia area, because of its proximity to metropolitan Albuquerque, is a logical home site area, and will experience growth problems in the future unless careful plans are made now. Small acreage subdivision of farm and rangeland has begun. Developers and county commissioners should take early action to plan and zone for suburbanization. The problems associated with unregulated development are hard to correct once established and bring social and political problems, devaluated land prices, and unsightly and unsanitary conditions.

OTHER AGENCY PROGRAMS AND THEIR IMPACTS

Other federal and state agencies have programs designed to develop water and land resources and to improve the economic well being of the people. Some of the benefits of these programs are very evident.

Planning and implementing programs to improve and extend irrigation and drainage of farm lands is being done by the U.S. Bureau of Reclamation (USBR) and the U.S. Bureau of Indian Affairs (BIA). Studies are being made by USBR for salvaging water through control of phreatophytic vegetation and elimination of open water and swampy areas. Range management programs involving controlled grazing, vegetation management, and erosion control are being accomplished by the Bureau of Land Management and the Bureau of Indian Affiars on lands under their jurisdiction. Prevention of overbank flooding, regulation of floodwaters, and improvement and rectification of stream channels are being studied by the Corps of Engineers.

The New Mexico Environmental Improvement Agency (EIA) has developed on-going programs of research, education, information, and enforcement in such water and related land fields as water quality, water supply, water control, and solid waste management. The EIA administers the Sanitary Projects Act which provides technical and monetary aid to small established communities for developing community water supplies. The agency is also instrumental in coordinating federal water quality programs with state needs.

Some of these authorities meet local and emergency situations only; others deal with problems that are essentially basinwide. More complete development of the basin's resources might be attained through better authorities, financing, and coordinated efforts between local interests and water resource development agencies.

Many federal agency programs further the economic well-being of both rural and urban people who need assistance. Frequently it is difficult for the layman to determine what the nature and purpose of a program is, what the eligibility requirements are, where to apply, which agency administers the program, and who to contact for information. A publication entitled "Catalog of Federal Assistance Programs" dated June 1, 1973, is a complete and accurate composite answering the above questions in detail. This catalog was produced by the Office of Economic Opportunity, Washington, D.C. 20506, and contains all domestic assistance programs of the federal government. Another publication entitled "Guide to Federal Programs for Rural Development", August 1973, was written by John H. Baker and is distributed by the National Area Development Institute. It brings together under one cover descriptions of all federal programs that target the rural area.

INTERAGENCY COORDINATION

Under existing USDA authorities, watershed protection, flood prevention, and land treatment projects are being planned, installed, and coordinated with the plans and projects of the Bureau of Reclamation, Corps of Engineers, Bureau of Indian Affairs, Bureau of Land Management, and other interested agencies.

Future resource development projects should have interagency coordination to insure that feasible features from all programs are included to make the most beneficial use of all resources. This coordination may range from informal contacts between individuals to formal liaison between organizations and agencies.

OTHER PROJECTS

During the course of the basin study, attention has repeatedly been called to a number of needs. Some of these follow:

1. Landing strip near Heron Dam would increase employment, improve access, and increase income from recreation.
2. Technical training school expansion in Espanola and El Rito featuring skills needed in the area and adjacent areas.
3. Possible garment manufacturing or electronic assembly plants.
4. La Tablas magnetite-taconite mining development.
5. La Madera-Petaca-Hopewell lake mining area redevelopment.
6. Access roads to mining areas.
7. All-weather roads along school bus routes.
8. Farm and ranch skills training for veterans.
9. Volunteer fire departments.
10. County fairgrounds and recreation centers.
11. Expanded potato production. Suitability will depend on availability of irrigation water.
12. Study to determine feasibility of growing special wheat, milling, packaging, shipping, and marketing of wheat.
13. Medical clinics.
14. Ambulance service.
15. Nursing homes.
16. Establish botanical gardens somewhere in the basin to exhibit the flora and fauna of the area.

APPENDIX I

Appendix I contains supplemental information including a glossary; list of plant names (common and scientific); description of land treatment systems; ownership data; climatic data; and five climatic data maps.

G L O S S A R Y

Acre-foot - A measure of the volume of water, equal to that required to cover one acre one foot in depth, equivalent to 43,560 cubic feet.

Afforestation - Establishment of a forest on an area not previously forested.

Allowable cut - The volume of wood that can be cut, under management, for a given period.

Alpine conditions (environment) - The ecological systems present in the area of frigid soils (below 47 degrees C. mean annual soil temperature). Quite often such areas are above timber line with a short growing season. Plants are primarily lichens and sedges.

Animal Unit (AU) - Considered to be one mature cow with calf or their equivalent.

Aquifer - A geologic formation, group of formations, or part of a formation that is water-bearing.

Bedrock - A general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.

Closed drainage basin - Refers to the topographic phenomena wherein surface drainages have no outlet to the sea and do not contribute surface flow under ordinary circumstances to major stream or through drainage systems.

Commercial forest land - Forest land that is producing or is physically capable of producing, usable crops of wood (usually sawtimber); economically available now or prospectively; not withdrawn from timber utilization.

Conservation Needs Inventory (CNI) - A collection of facts useful to USDA and other federal and state agencies in carrying out responsibilities for adequate conservation in New Mexico's soil and water resources. The data in the inventory is concerned with land use, conservation treatment needs, and watershed and river basin problems and needs.

Desert conditions (environment) - The ecological systems present in the area of thermic soils (above 59 degrees C. mean annual soil temperature), and where annual average precipitation is less than 8 inches.

Diameter, breast high (DBH) - The diameter of a tree at 4.5 feet above average ground level.

Forest land - Land that is at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime.

Forest management - All activities involved in protecting and managing forest lands for the production of timber and related products.

Fragile soil - Highly erodible soil (due to inherent natural characteristics), which when excessively disturbed by foot, hoof, or wheel, will wash or blow away with high winds or intensive rainfall.

Growing stock - Refers only to sawtimber trees and pole timber trees: i.e., all live trees 5.0 inches DBH and larger (except cull trees). In this discussion, saplings and seedlings are not part of growing stock in this usage of the term.

Land capability - The grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on the limitations of the soils, their risk of damage when they are used, and the way they respond to treatment when used for the common field crop and forage crops. There are eight capability classes.

Land resource area (LRA) - Geographic area of land (usually several thousand acres in extent) that is characterized by particular patterns of soil, climate, water resources, land use, and type of farming.

Mixed conifer type - A forest type represented by a mixture of Douglas Fir, Ponderosa pine, aspen, true firs, and spruce near the upper limits. Many present stands of aspen and Ponderosa pine have an understory of Douglas Fir and white fir that will eventually replace the overstory unless management practices or fire change the trend in succession.

Noncommercial forest land - Forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site condition of forest land so physically inaccessible as to be unavailable economically in the foreseeable future; lands withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land.

Project work inventory (PWI) - Is a type of Forest Service inventory of listing the non-recurrent work that should be initiated on each unit to meet public needs.

Rangeland - All land producing native forage for animal consumption and lands that are revegetated naturally or artificially to provide a forage cover that is maintained like native vegetation.

Related land - Refers to land that is associated with water resource developments either through the effects of the land on the water resources or the effects of the water resources and their developments on the land.

Riparian - Situated or dwelling on the bank of a river or other body of water.

Thermal waters - Ground water (either pumped or free flowing as in springs) that is heated by geological heat sources.

Tri-culture - The ethnic group "makeup" of New Mexico--Anglo Saxon, Indian, and Spanish.

Visitor day - Refers to a one-time visit by one person to a tourist attraction such as a national monument or park or to a recreation site such as a resort, lake, or other development.

Water available - Water available (surface and ground water) to meet the existing and projected needs.

Water depletions - All water diverted from the supply system. Part is depletion, and part is returned to the system.

Water need - Projected quantity of water required in excess of the supply.

Water salvage - One-half the water depleted by phreatophytes growing in 1964.

Water savings - Water depletions which can be reduced by control of the spread of phreatophytes and increasing the efficiency of irrigation water transport systems, and on-farm application.

PLANT NAMES

Common Use	Scientific
Alder	Alnus Tenuifolia
Alkali sacaton	Sporobolus airoides
Alligator juniper	Juniperus pachyphloea
Antelope Bitterbrush	Purshia tridentata
Apacheplume	Fallugia paradoxa
Arizona fescue	Festuca arizonica
Ash	Fraxinus pennsylvanica
Big bluestem	Andropogon gerardi
Big sagebrush	Artemisia tridentata
Black grama	Bouteloua eriopoda
Blue grama	Bouteloua gracilis
Bluegrass	Poa spp.
Bottlebrush squirreltail	Sitanion hystrix
Buckwheat	Eriogonum spp.
Catclaw	Acacia greggii
Ceancthus	Ceanothus spp.
Cholla	Opuntia spp.
Cliffrose	Cowania spp.
Clover	Trifolium spp.
Colorado Blue Spruce	Picea pungens
Corkbark fir	Abies lasiocarpa var. arizonica
Creosotebush	Larrea divaricata
Douglas Fir	Pseudotsuga menziesii
Engelmann Spruce	Picea engelmanni
Fourwing saltbush	Atriplex canescens
Galleta	Hilaria jamesii
Gamble Oak	Quercus gambelii
Geranium	Geranium spp.
Greasewood	Sarcobatus vermiculatus
Indian ricegrass	Oryzopsis hymenoides
Junegrass	Koeleria cristata
Limber Pine	Pinus flexilis
Little bluestem	Andropogon scoparius
Live Oak	Quercus turbinella; pungens; grisea
Lovegrass	Eragrostis spp.
Mesquite	Prosopis juliflora
Mountain mahogany	Cercocarpus montanus
Mountain muhly	Muhlenbergia montana
Muttongrass	Poa fendleriana
Needleandthread	Stipa comata
New Mexico Locust	Robinia neo-mexicana
One-seeded juniper	Juniperus monosperma
Peavine	Lathyrus spp.

PLANT NAMES (Contd)

Common Use	Scientific
Pinedropseed	Blepharoneuron tricholepis
Pingue	Hymenoxys richardsonii
Pinyon pine	Pinus edulis
Ponderosa pine	Pinus ponderosa
Poplar (Cottonwood)	Populus spp.
Pricklypear	Opuntia polyacantha
Quaking Aspen	Populus tremuloides
Rabbitbrush	Chrysothamnus
Rocky Mountain Juniper	Juniperus scopulorum
Russianthistle	Salsola kali
Russian olive	Elaeagnus angustifolia
Saltcedar	Tamarix pentandra
Saltgrass	Distichlis
Sand dropseed	Sporobolus cryptandrus
Sedge	Carex spp.
Sideoats grama	Boutelous curtipendula
Shadscale	Atriplex confertifolia
Snakeweed	Gutierrezia sarothrae
Tamarisk	Tamarix pentandra
Tarbush	Flourensia cernua
Tarweed	Madia spp.
Threeawn grass	Aristida
Thurber fescue	Festuca thurberi
Timothy	Phleum
Tobosa	Hilaria mutica
Utah Juniper	Juniperus utahensis
Vetch	Vicia spp.
Western wheatgrass	Agropyron smithii
White fir	Abies concolor
Willow	Salix spp.
Winterfat	Eurotia lanata

LAND TREATMENT SYSTEMS

Following are procedures used by the New Mexico river basin investigation field party in developing a framework within which land treatment programs for the future can be planned. The framework involves a set of land treatment systems which landowners and operators as well as land administering agencies might find useful in evaluating land treatment plans. The framework in no way dictates a land treatment program; but, instead, sets forth a list of land treatment systems from which we can determine approximate investment costs in terms of money and manpower from which we might expect monetary benefits, employment opportunities, and other impacts. The list of land treatment systems was developed to avoid a list involving specific land treatment practices for three reasons: (1) various land administering agencies choose land treatment practices and variations of these practices to suit their own needs, (2) these practices are often known by different names by different agencies, and (3) the framework needs to be general and designed so that any combination of land treatment practices can be developed into a comprehensive program within the framework.

BOTTOMLAND VEGETATION MANAGEMENT AREAS

Bottomland Management

Bottomland management applies to bottomland that supports woody vegetation or grassland. The management objective is to maintain or improve the vegetation to provide grazing, recreation, wildlife habitat, streambank protection, or for aesthetic purposes. Management is achieved by thinning and grazing as dictated by the management objective.

Phreatophyte Control

Phreatophyte control is applicable to the bottomlands that support water-loving woody vegetation. The management objective is to increase forage production for livestock and wildlife, salvage water used by the woody plants in harmony with aesthetic and landscape values, and the protection of wildlife habitat. Control is achieved by suppression of woody vegetation in selected areas by clearing, thinning, shredding, or spraying. This treatment is followed by re-establishing adapted grasses and using applicable range management practices. Necessary subsurface drains to lower the water table in the treatment area are also included in this system.

BRUSHLAND MANAGEMENT AREAS

Brush Control

Brush control applies to land with sufficient brush cover to cause or threaten the reduction of more desirable forage species and where the soils and slopes make control feasible. The principal brush species are big or sand sage, mesquite, creosotebush, chaparral, cactus, rabbitbrush, and yucca. The objective is to suppress the brush and obtain a more desirable ratio with productive range species that yield more food for livestock and wildlife. Control is obtained by plowing, shredding, spraying, grubbing, or prescribed burning, supplemented by solid or spot seeding of desirable grass species as needed, deferred grazing on the treated area, applicable range management practices, and treatment to control erosion where needed. Where control areas are extensive, provision is made to retain and protect a sufficient amount of quality habitat for the wildlife population.

Brushland Management

Brushland management applies to areas with sufficient brush cover to cause or threaten the reduction of more desirable forage species where soil, slope, or other conditions make control unfeasible. The principal brush species include big sage, mesquite, creosotebush, gamble oak, cactus, rabbitbrush, and yucca. The management objective is to reduce spreading and maintain a desirable ratio of forage and browse for livestock and wildlife. Management is obtained by the applicable practices shown under range management.

CRITICAL EROSION MANAGEMENT AREAS

Applicable to any area that requires intensive treatment to control erosion (soil removal of greater than 1.0 acre-foot/square mile/year). The management objective is to minimize erosion, reduce sediment yield, and wherever possible, restore the area to productive use. Management is obtained by the applicable combination of livestock exclusion or harvesting for vegetative improvement only, structures for gully control, water spreading devices, diversion terraces, fencing, and critical area seeding or transplanting, and fertilization.

CROP, PASTURE, AND HAYLAND MANAGEMENT AREAS

Abandoned Cropland Management

Abandoned cropland management is applicable to previously cultivated lands that are not well revegetated or vegetated with plants of negligible value. The management objective is to reduce erosion, increase infiltration, reduce sediment yields, and increase forage production. Management is achieved by use of dead litter cover and seeding of

adapted grass or woody plant species, needed mechanical erosion control, followed by the applicable management of forage plants.

Irrigated Land Management

Irrigated land management applies to all land that is developed for irrigation. The management objective is to sustain or increase crop yields, increase irrigation efficiency, maintain or improve soil physical condition and fertility while protecting from erosion. Management is obtained through a combination of improved irrigation systems, drainage, irrigation water management, conservation cropping systems, and crop residue, pasture and hayland management. NOTE: Irrigation systems are designed for efficient irrigation and include realignment and/or lining irrigation canals, laterals and field ditches, irrigation pipelines, sprinkler systems, land leveling, tailwater recovery facilities, surface and subsurface drainage, and other water control structures.

Non-Irrigated Cropland Management

Non-irrigated cropland management (dry cropland) applies to non-irrigated land managed for crop, pasture, or hay production. The management objective is to maintain or improve soil physical condition and fertility, reduce erosion and dust pollution, and improve the quality and quantity of crop yields. Management is obtained by the applicable combinations of dry cropland practices such as conservation cropping systems, strip cropping, contour farming, diversion terraces, crop residue use, pasture and hayland management.

FOREST LAND MANAGEMENT AREAS

Aspen Management

Aspen management applies to relatively large and pure stands of aspen. Management objectives may be for aesthetic value, forage production, watershed protection, increased water yield, or fiber production. Management is achieved by proper grazing, fire protection, selective or patch cutting, tree planting, and improvement or protection of wildlife habitat.

Pinyon-Juniper Control

Pinyon-juniper control applies to areas supporting pinyon-juniper on deep or moderately deep soils on moderate slopes. Objectives include increasing forage production for livestock and wildlife, reducing sediment yield, and maintaining or improving wildlife habitat. Control is obtained by removal of trees in patterns to maintain needed wildlife cover, spot or solid seeding of desirable grass species, planned grazing systems, and applicable range management practices.

Ponderosa Pine Management

Ponderosa pine management applies to commercial stands of Ponderosa pine (site index greater than 45) that are accessible for harvest. Management objectives include increasing timber products, watershed protection, and increasing water yield and forage production for livestock and wildlife. Management is achieved by harvest cutting, thinning, pruning, tree planting, grass seeding, proper grazing, watershed protection, fire protection, and improvement or protection of wildlife habitat.

Ponderosa Pine, Pinyon-Juniper Management

Ponderosa pine, pinyon-juniper management applies to noncommercial Ponderosa pine (less than 45 site index) and to pinyon-juniper areas. Management objectives include increased forage production for livestock and big game, some wood products, and reduced sediment yields. Management is obtained through proper grazing and applicable range management practices.

Spruce-Fir Management

Spruce-fir management applies to stands of spruce-fir and mixed conifer types. Management objectives include increases of water yield, timber harvest, and forage production. Management is achieved by the applicable combination of block and strip cutting of spruce-fir and selective or block cutting of mixed conifer, tree planting, and fire protection.

GRASSLAND MANAGEMENT AREAS

Range Management

Range management applies to open grassland that is not included in snow pack management or critical erosion management. The management objectives are to sustain or increase forage production, minimize erosion and reduce sediment yield. Management is achieved through a combination of deferred grazing, planned grazing systems, proper grazing use, and adequate water facilities, fences, planned access and service roads, and salt placement to control livestock distribution.

Snow Pack Management

Snow pack management applies to open grassland at elevations above 10,000 feet. The management objective is to increase water yield from snowfall. Management is achieved by construction of barriers to create drifts and may include treatment to regulate the period of melting.

TABLE AI-1. AREAS IN UPPER RIO GRANDE BASIN, NEW MEXICO - OWNERSHIP BY COUNTY (AREA IN ACRES)

County	Area	Indian	National Forest	Bureau of Land Mgt.	Defense	Misc. Federal	State Trust	State Deeded	Private
Taos	1,444,480	62,288	534,917	207,112	0	0	76,714	20,430	543,019
Rio Arriba	2,459,520	149,689	1,245,285	171,330	193	6,195	37,200	21,249	828,379
Mora	14,080	0	14,080	0	0	0	0	0	0
Santa Fe	1,182,080	79,548	228,132	83,587	770	1,172	76,773	7,144	704,954
Los Alamos	69,120	0	27,340	0	21,926	19,854	0	0	0
Sandoval	2,112,640	502,530	380,921	497,249	0	27,620	70,355	3,437	630,528
McKinley	1,027,200	269,060	102,717	206,950	0	0	68,047	15,557	364,869
Valencia	2,714,880	695,251	266,009	342,953	0	34,290	152,573	8,785	1,215,019
Socorro	3,811,200	56,680	622,847	840,576	235,418	420,230	514,273	10,100	1,111,076
Catron	1,372,800	0	327,589	158,490	0	0	267,110	0	619,611
Sierra	726,400	0	19,168	177,640	90,660	40,056	65,780	0	333,096
Lincoln	5,760	0	4,957	0	0	0	0	0	803
Torrance	1,269,760	16,300	125,922	41,137	102	145	173,142	6,253	906,759
Bernalillo	748,160	222,527	74,906	17,225	54,537	5,968	23,581	8,620	340,796
San Miguel	46,720	0	16,736	560	0	0	10,100	0	19,324
Colfax	420	0	420	0	0	0	0	0	0
TOTAL BASIN	19,005,220	2,053,873	3,991,946	2,744,809	403,606	555,530	1,535,648	101,575	7,618,233
Area in SqMi	29,695.7	3,209.2	6,237.4	4,288.8	630.6	868.0	2,399.5	158.7	11,903.5
Percent	100.0	10.8	21.0	14.4	2.1	2.9	8.2	0.5	40.1

CLIMATIC DATA

Table AI-2, page AI-12, is a listing of selected climatic stations grouped by Land Resource Areas (LRA's) with some important climatic data listed. These are all based on the time of record of each station.

The table lists average precipitation for annual and winter months and percent of annual precipitation that falls in the winter months; mean annual temperature, maximum and minimum temperature; crop irrigation requirement; average annual gross lake evaporation; and average frost-free periods by number of days.

TABLE AI-2. TYPICAL CLIMATIC CONOITIONS BY LAND RESOURCE AREA, UPPER RIO GRANOE BASIN, NEW MEXICO (1965)

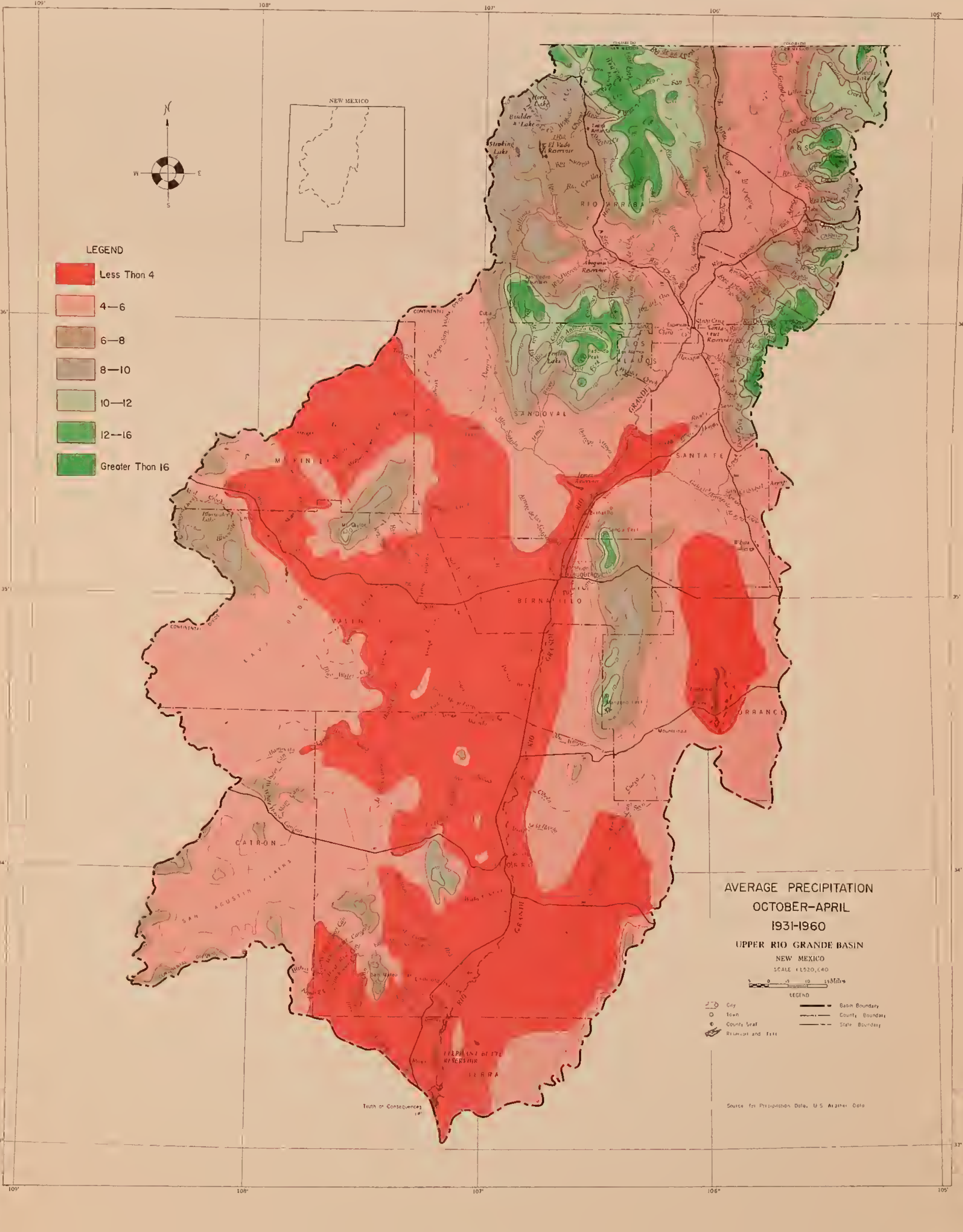
OATA FOR THE VICINITY OF	Elevation (feet)	Annual Precipitation (inches)	October-March Precipitation (inches)	Winter Precipitation (%)	Mean Annual Temperature (°F)	Maximum Temperature (°F)	Minimum Temperature (°F)	CIR 1/	Average Annual Gross Lake Evaporation (inches)	AVERAGE FROST-FREE PERIOO FROM	TO	DAYS
NEW MEXICO AND ARIZONA PLATEAUS ANO MESAS (WP) LANO RESOURCE AREA												
Cuba	7,045	13.8	8.6	62	46.5	-	-40	1.11	41	6/7	9/20	105
Regina	7,450	16.2	6.4	40	45.2	106	-30	-	40	6/3	9/25	114
Star Lake	7,100	8.0	2.8	35	47.6	101	-29	-	-	-	-	-
Bandelier Natl. Monument	6,061	15.3	5.4	35	40.3	106	-23	-	52	-	-	-
Santa Fe	7,200	14.1	4.7	34	49.2	98	-18	-	53	-	-	-
Floyd Lee Ranch	7,200	8.3	2.9	34	-	-	-	-	44	-	-	-
San Fidel	6,160	9.9	2.8	28	51.5	103	-20	1.64	55	5/2	10/18	168
Laguna	5,800	9.9	3.1	31	53.4	103	-20	1.64	61	5/2	10/16	166
Magdalena	6,540	11.9	3.4	28	52.1	102	-21	-	55	5/1	10/15	166
Agustine	7,020	10.5	3.2	30	47.9	100	-26	2.20	48	5/25	9/30	128
Oanley Ranch	6,800	9.8	2.9	30	49.6	101	-12	1.32	-	-	-	-
Espanola	5,595	9.8	3.3	34	51.2	106	-23	1.53	49	5/12	10/5	145
Alcalde	5,680	8.8	3.4	38	50.0	100	- 7	-	48	-	-	-
Ghost Ranch	6,460	10.5	3.9	37	-	-	-	-	46	-	-	-
Nambe	6,050	9.9	3.5	36	-	-	-	1.60	46	-	-	-
SOUTHERN ROCKY MOUNTAIN (RM) LANO RESOURCE AREA												
Chama	7,800	20.96	10.4	50	42.6	99	-28	0.88	40	6/9	9/23	106
El Vado Oam	6,750	13.88	6.3	45	45.2	101	-35	-	42	-	-	-
Tierra Amarilla	7,766	16.0	6.9	43	44.1	102	-40	1.03	42	-	-	-
Cumbres (Colorado)	10,015	33.8	18.0	53	-	-	-	-	36	-	-	-
Bateman Ranch	8,900	23.2	10.8	47	-	-	-	-	44	-	-	-
Santa Fe Lake	11,600	35.1	15.6	44	-	-	-	-	44	-	-	-
Wolf Canyon	8,150	21.9	9.0	42	40.1	99	-41	-	46	-	-	-
Truchas	-	15.0	4.9	33	45.2	99	-32	1.01	-	5/26	9/23	121
Jemez Springs	6,055	17.7	6.3	36	51.8	98	-16	1.30	52	5/2	10/21	172
Los Alamos	7,410	18.1	5.7	31	48.1	102	-18	-	50	-	-	-
Red River	8,676	20.5	7.7	38	39.3	94	-35	-	41	-	-	-
SOUTHERN OESERTIC BASIN PLAINS AND MOUNTAINS (SD) LAND RESOURCE AREA												
Bernalillo	5,045	8.4	3.3	39	54.5	109	-18	1.95	67	5/3	10/10	159
Albuquerque	5,311	8.1	2.9	35	56.6	104	-13	2.01	70	5/3	10/12	161
Los Lunas	4,840	8.1	2.8	34	-	-	-	2.11	70	5/3	10/15	164
Belen	4,800	7.0	2.7	28	56.6	109	- 7	2.22	71	4/22	10/17	177
Socorro	4,617	8.8	2.6	29	57.8	108	-16	2.11	72	4/14	10/28	180
Bosque del Apache	4,520	7.8	2.5	31	58.2	113	- 9	2.10	73	4/13	10/24	175
Engle	5,820	9.1	2.6	28	-	-	-	-	72	-	-	-
Elephant Butte Oam	4,576	8.6	2.5	29	60.3	109	- 5	2.57	75	3/27	11/12	200
Jemez Dam	-	7.6	3.3	43	-	-	-	-	67	-	-	-
ARIZONA ANO NEW MEXICO MOUNTAINS (RM2) LAND RESOURCE AREA												
Sandia Crest	10,675	22.3	11.8	53	-	-	-	-	-	-	-	-
Sandia Park	7,011	18.2	7.7	42	-	-	-	-	-	-	-	-
Tajique	7,100	18.6	7.1	38	47.4	96	-21	-	47	5/20	10/3	136
Marquez	7,800	11.8	4.0	33	-	-	-	-	-	-	-	-
Kelly Ranch	6,700	13.9	4.1	29	-	-	-	-	-	-	-	-
Rienhardt Ranch	5,450	8.1	2.2	28	-	-	-	-	-	-	-	-
Bingham	5,453	9.1	2.8	31	55.5	-	- 8	-	61	5/3	10/22	171
Stanley	6,380	10.8	3.3	31	-	-	-	-	51	5/14	10/6	123
Estancia	6,107	12.3	3.6	37	50.0	102	-33	1.13	51	5/18	10/2	138
McIntosh	6,250	12.5	3.5	28	50.2	98	-26	1.13	51	5/18	10/13	149
Mountainair	6,520	15.1	5.2	35	50.8	99	-24	-	50	5/7	10/9	155
HIGH INTERMOUNTAIN VALLEYS (HV) LANO RESOURCE AREA												
Tres Piedras	8,110	14.7	5.6	38	42.1	92	-35	0.85	42	-	-	-
Cerro	7,665	13.0	4.3	33	44.2	100	-34	1.01	44	5/30	9/25	118
Taos	6,945	12.6	4.8	38	47.4	101	-27	1.15	46	5/28	9/30	125
Penasco	7,900	15.2	6.3	41	-	-	-	1.36	45	6/25	9/30	97

1/ "CIR"- is consumptive irrigation requirement = "U" - "R" (acre-feet per acre). "U" - is seasonal crop consumptive use; "R" - is sum of monthly effective rainfall for the growing season. Compiled from USWB publications and New Mexico State Engineer Publication.

B A S I C D A T A M A P S

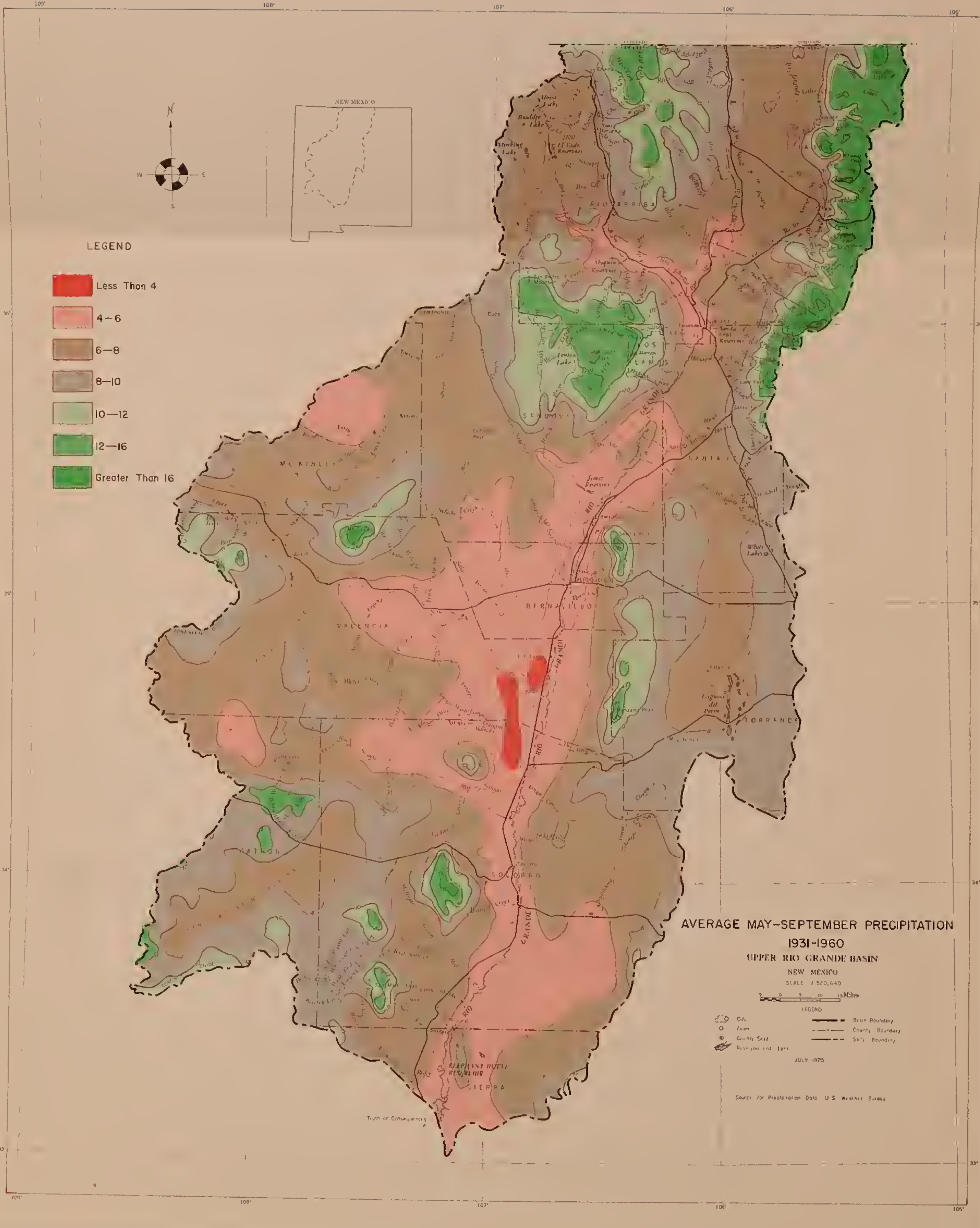
Maps of the basin are included for use and interpretation where needed. The precipitation and temperature maps were developed from U. S. Weather Bureau maps. The Average Annual Lake Surface Evaporation and Potential Evapotranspiration in Inches for Frost-Free Season maps were developed by the State Engineer and River Basin Field staff.

Maps showing average annual temperature and precipitation, lake surface evaporation, and evapotranspiration are included.



LEGEND
Less Than 4
4—6
6—8
8—10
10—12
12—16
Greater Than 16
NEW MEXICO
AVERAGE PRECIPITATION
OCTOBER–APRIL
1931-1960
UPPER RIO GRANDE BASIN
NEW MEXICO
RIO ARRIBA
SANDOVAL
LOS ALAMOS
SANTA FE
BERNALILLO
TORRANCE
CATRON
SOCORRO
SIERRA
VALENCIA
McKINLEY
SAN AGUSTIN PLAINS
RIO GRANDE
Truth or Consequences

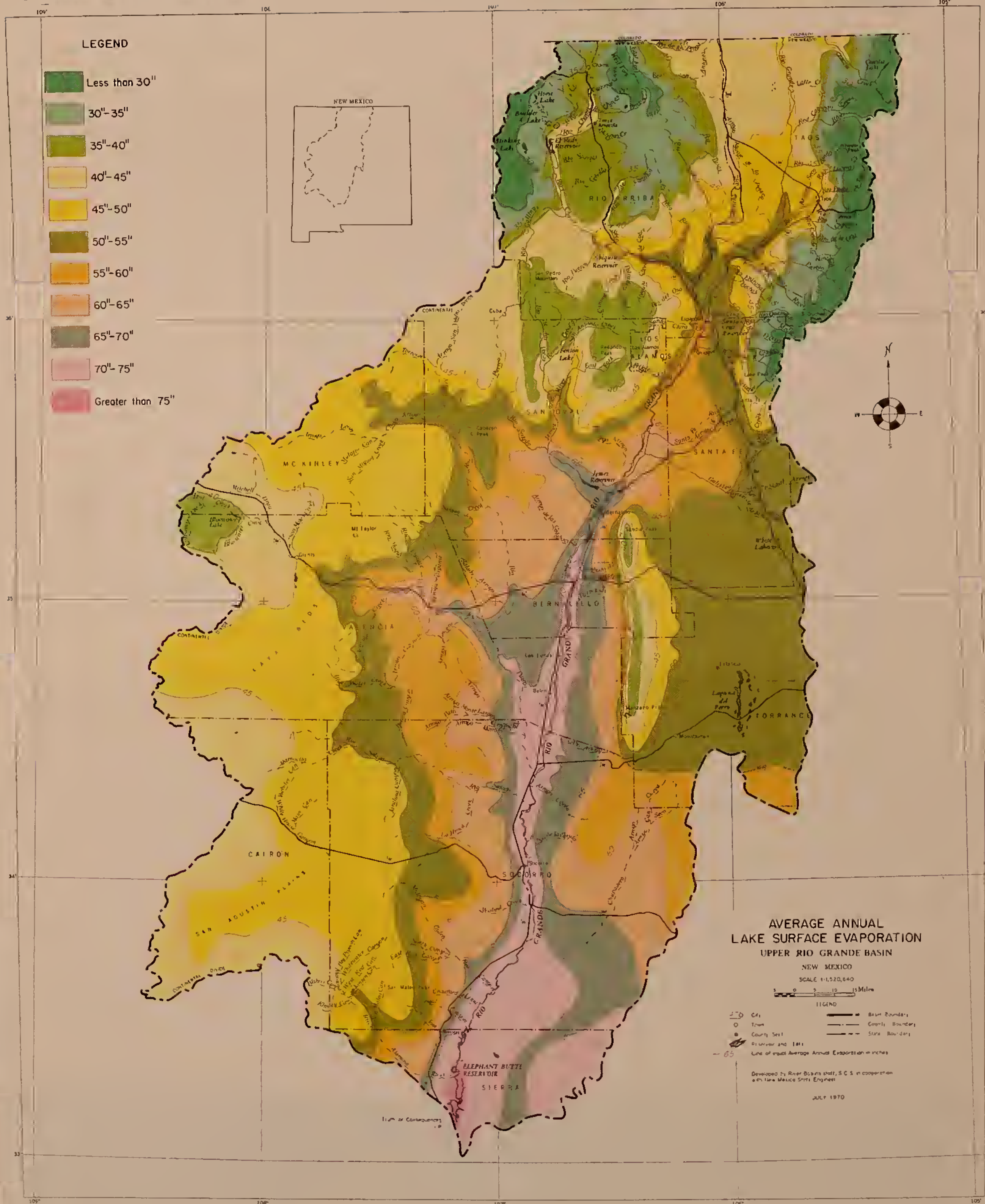
M7-S-21633-N


AVERAGE MAY–SEPTEMBER PRECIPITATION
1931-1960
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:520,640
Miles
LEGEND
Less Than 4
4–6
6–8
8–10
10–12
12–16
Greater Than 16
NEW MEXICO
N
S
W
E
RIO ARRIBA
SANDOVAL
LOS ALAMOS
SANTA FE
McKINLEY
VALENCIA
BERNALILLO
TORRANCE
SOCORRO
CATRON
SIERRA
RIO GRANDE
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
JULY 1970
Source for Precipitation Data U.S. Weather Bureau

M7-S-21634-N

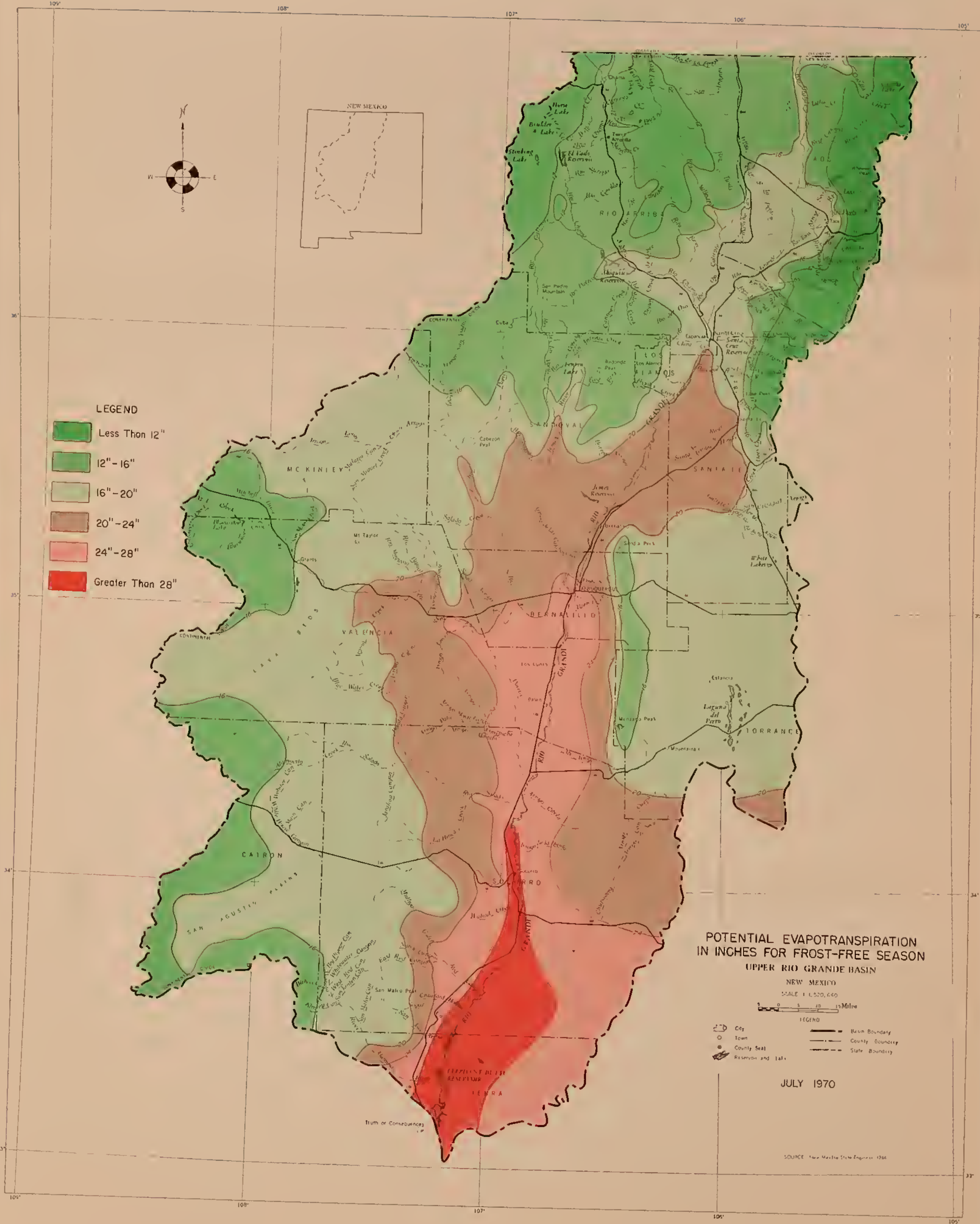
U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO

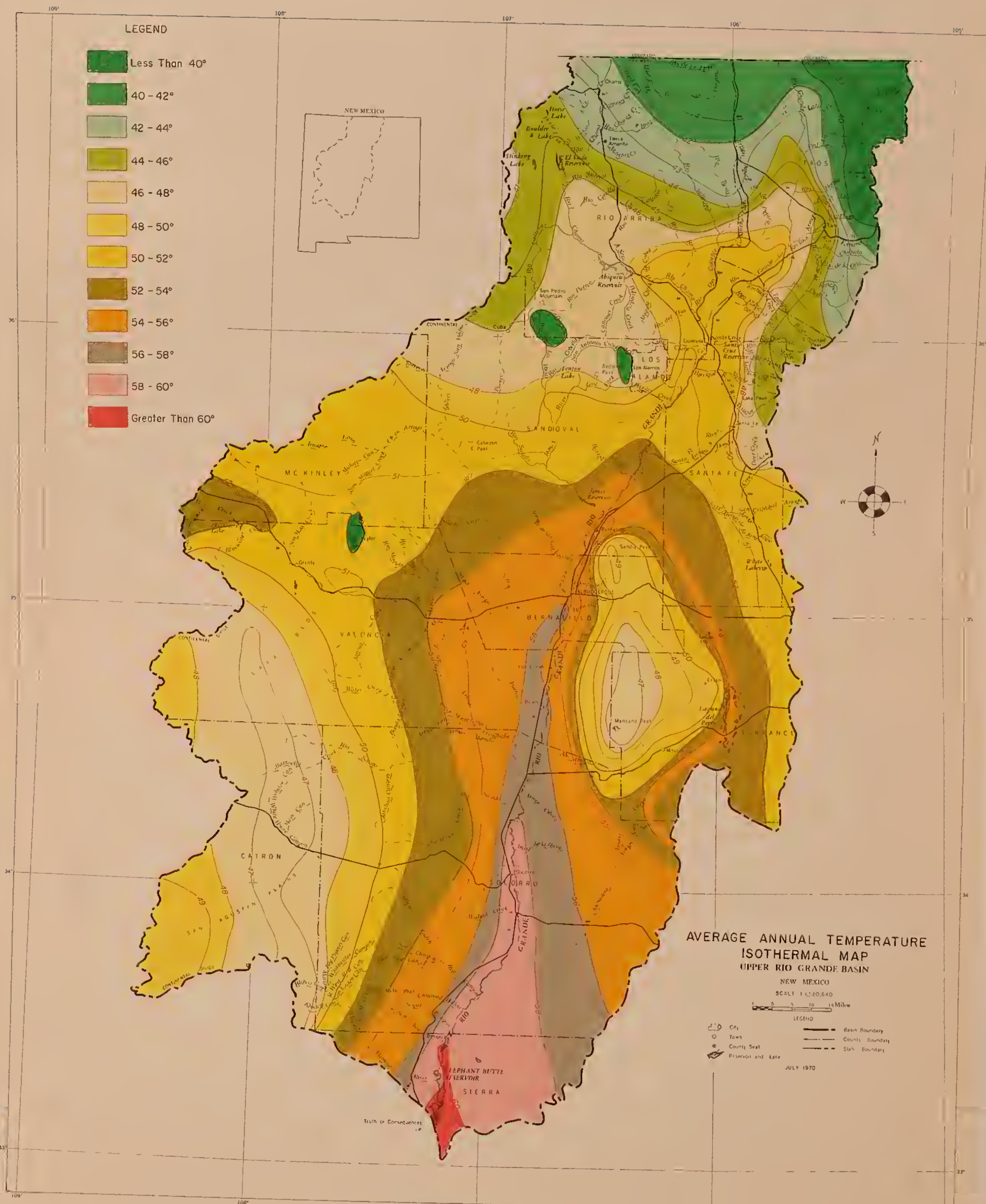


USDA SCS FORT WORTH, TEX. 1970

REVISED NOVEMBER 1974 4—R—34450


LEGEND
Less Than 12"
12"-16"
16"-20"
20"-24"
24"-28"
Greater Than 28"
NEW MEXICO
MC KINLEY
SANDOVAL
RIO ARRIBA
LOS ALAMOS
SANTA FE
BERNALILLO
VALENCIA
TORRANCE
CATRON
SOCORRO
SIERRA
SAN AUGUSTIN PLAINS
RIO GRANDE
Truth or Consequences
POTENTIAL EVAPOTRANSPIRATION
IN INCHES FOR FROST-FREE SEASON
UPPER RIO GRANDE BASIN
NEW MEXICO
LEGEND
City
Town
County Seat
Basin Boundary
County Boundary
State Boundary
JULY 1970

M7-S-21637-N


LEGEND
Less Than 40°
40 - 42°
42 - 44°
44 - 46°
46 - 48°
48 - 50°
50 - 52°
52 - 54°
54 - 56°
56 - 58°
58 - 60°
Greater Than 60°
NEW MEXICO
RIO ARRIBA
LOS ALAMOS
SANDOVAL
McKINLEY
SANTA FE
BERNALILLO
VALENCIA
TORRANCE
CATRON
SOCORRO
SIERRA
RIO GRANDE
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
AVERAGE ANNUAL TEMPERATURE
ISOTHERMAL MAP
UPPER RIO GRANDE BASIN
NEW MEXICO
JULY 1970
N
W
E
S

M7-S-21636-N

[redacted]

UPPER RIO GRANDE BASIN

WATER AND RELATED LAND RESOURCES

APPENDIX II

(WATERSHED INVESTIGATION REPORTS)

NEW MEXICO

4-34722-B 2-75
USDA-SCS-FORT WORTH, TEX. 1975

COVER PHOTO:
Elephant Butte in Elephant Butte Reservoir.

U.S. FOREST SERVICE PHOTO

U P P E R R I O G R A N D E B A S I N

WATER AND RELATED LAND RESOURCES

A P P E N D I X II

(WATERSHED INVESTIGATION REPORTS)

A REPORT BASED ON A COOPERATIVE STUDY BY

UNITED STATES DEPARTMENT OF AGRICULTURE

AND THE

NEW MEXICO STATE ENGINEER

PREPARED BY

Economic Research Service-Forest Service-Soil Conservation Service

OCTOBER 1974

4-34722-B 2-75

APPENDIX II

This appendix contains 19 watershed investigation reports. These watersheds were selected because they have Public Law 566 potential for solving water and related land resource problems. The proposed projects appear to be physically and economically feasible and should be initiated as soon as possible.

CONTENTS

MAPS

MAPS

FACING PAGE:

PHOTOS

PHOTOS

PHOTOS

TABLES

TABLES

TABLES

TABLES

TABLES

TABLES

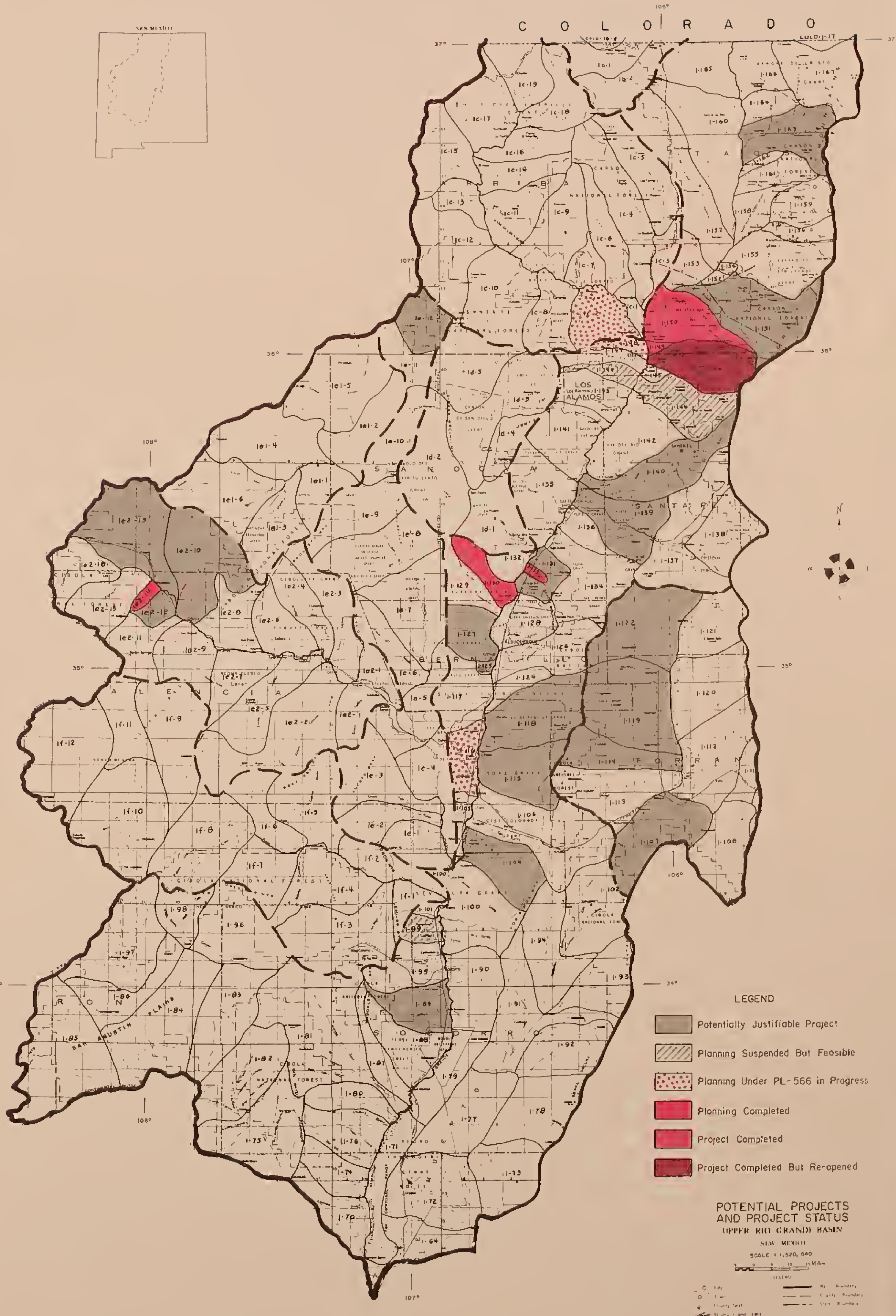
TABLES

TABLES

TABLES

TABLES

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO



NOVEMBER 1974 4-R-34445

TABLE AII-1. ESTIMATED COSTS OF STRUCTURAL MEASURES AND DISTRIBUTION OF COSTS BETWEEN FEDERAL FUNDS AND NON-FEDERAL FUNDS ON POTENTIAL WATERSHED PROJECTS, UPPER RIO GRANDE BASIN, NEW MEXICO

Name and CNI Number of Watershed		1969 Price Base (Dollars) Estimated Total Cost of Instal-lation	Estimated Federal Cost of Instal-lation	Estimated Non-Federal Cost of Instal-lation
INDEPENDENT WATERSHEDS				
Rio Grande Tributaries				
1. Red River	(1-163)	3,567,200	3,542,000	25,200
2. Embudo River	(1-151)	1,432,200	1,271,500	160,700
3. Pojoaque Creek	(1-144)	3,046,100	3,030,000	16,100
4. Santa Fe River	(1-140)	1,373,100	1,327,000	46,100
5. Galisteo Creek	(1-139)	229,900	224,700	5,200
6. Rito Leche & Nacimiento	(1e-12)	1,082,000	1,037,000	45,000
Sub Total		10,730,500	10,432,200	298,300
Estancia Closed Basin				
7. Rock Lake	(1-107)	2,482,000	2,445,100	36,900
8. Tajique	(1-114)	1,366,000	1,240,500	125,500
9. Buffalo Springs	(1-119)	2,934,800	2,865,700	69,100
10. Hyer Draw	(1-122)	3,780,700	3,614,500	166,200
Sub Total		10,563,500	10,165,800	397,700
INTERRELATED WATERSHEDS				
Rio Grande Tributaries				
11. Pajarito Arroyos	(1-125)	5,039,000	4,017,000	1,022,000
12. Hell's Canyon	(1-118)	6,280,000	6,133,000	147,000
13. Canyon Sales	(1-115)	1,679,000	1,607,000	72,000
14. Pino Draw	(1-104)	2,615,000	2,569,000	46,000
15. Lemitar-Polvadera	(1-99)	1,954,000	1,938,000	16,000
16. Walnut Creek	(1-89)	4,200,000	4,115,000	85,000
Sub Total		21,767,000	20,379,000	1,388,000
Rio San Jose				
17. San Mateo-Grants Canyon	(1e2-10)	1,704,000	1,322,000	382,000
18. Pole Zuni Canyons	(1e2-12)	432,000	411,000	21,000
19. Rio San Jose	(1e2-13)	1,501,000	1,494,000	7,000
Sub Total		3,637,000	3,227,000	410,000
BASIN TOTAL		46,698,000	44,204,000	2,494,000

Source: Soil Conservation Service Watershed Investigation Reports

TABLE AII-2. SUMMARY COSTS AND BENEFITS OF POTENTIAL WATERSHED PROJECTS, UPPER RIO GRANDE BASIN, NEW MEXICO

Name and CNI Number of Watershed 1/		Structural Measures: Average Annual Costs $ 2/	Average Annual Benefits $	Benefit-Cost Ratio
INDEPENDENT WATERSHEDS				
Rio Grande Tributaries				
1. Red River	(1-163)	199,900	228,600	1.1:1
2. Embudo River	(1-151)	89,800	126,600	1.6:1
3. Pojoaque Creek	(1-144)	167,900	161,100	1.0:1
4. Santa Fe River	(1-140)	78,400	79,000	1.0:1
5. Galisteo Creek	(1-139)	12,800	14,900	1.2:1
6. Rito Leche & Nacimiento	(1e-12)	61,200	79,600	1.3:1
Sub Total		601,000	689,800	
Estancia Closed Basin				
7. Rock Lake	(1-107)	148,100	168,800	1.1:1
8. Tajique	(1-114)	83,800	84,500	1.0:1
9. Buffalo Springs	(1-119)	174,600	195,000	1.1:1
10. Hyer Draw	(1-122)	231,300	306,700	1.3:1
Sub Total		637,800	755,000	
INTERRELATED WATERSHEDS				
Rio Grande Tributaries				
11. Pajarito Arroyos	(1-125)	291,000	421,500	1.4:1
12. Hell's Canyon	(1-118)	356,300	423,100	1.2:1
13. Canyon Sales	(1-115)	95,600	127,500	1.3:1
14. Pino Draw	(1-104)	149,900	206,600	1.4:1
15. Lemitar-Polvadera	(1-99)	111,800	122,300	1.1:1
16. Walnut Creek	(1-89)	238,600	298,000	1.2:1
Sub Total		1,243,200	1,599,000	
Rio San Jose				
17. San Mateo-Grants Canyon	(1e2-10)	103,500	112,400	1.1:1
18. Pole Zuni Canyons	(1e2-12)	25,200	37,200	1.5:1
19. Rio San Jose	(1e2-13)	88,600	153,600	1.7:1
Sub Total		217,300	303,200	
BASIN TOTAL		2,699,300	3,347,000	1.2:1

1/ Numerical listing does not imply priority
2/ Installation costs amortized @ 5-3/8 percent interest for 100 years. Total includes $2,523,600 as the amortized cost of installation and average annual estimated operation and maintenance cost of $175,700.
Source: Soil Conservation Service Watershed Investigation Reports.

RED RIVER WATERSHED
(CNI 1-163)
TAOS COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located in northern Taos County east of the Rio Grande. Red River, a tributary of the Rio Grande, is the principal stream. Cabresto Creek, a major tributary, enters the river at Questa. The watershed has an area of about 216 square miles of which about 10 percent is privately owned, 2 percent is state land, and the remaining 88 percent is federal land, primarily National Forest.

The town of Questa, at the junction of State Highways 3 and 38, and the resort town of Red River are in the watershed. The major flood damage occurs near and in the town of Red River.

Altitudes range from about 6,600 feet above mean sea level on the Rio Grande to 13,160 feet at the top of Mount Wheeler. The entire watershed is in the Southern Rocky Mountains Land Resource Area. Average annual precipitation ranges from 12 inches at Questa to about 30 inches in the mountains.

The principal land use is for grazing livestock. There are about 3,800 acres of irrigated land serviced by 8 ditch systems. The principal crops are small grains, alfalfa, and grass hay or pasture.

National Forest land in this watershed is administered by the Questa District Ranger as a portion of the Carson National Forest.

The approximate area is 175 square miles; classed 75 percent commercial, 24 percent non-commercial forest, and 1 percent grassland.

The Project Work Inventory lists needs for vegetative control range improvements, fuel treatment, erosion control, timber state improvement and fish and wildlife habitat improvement. All these needs should be given consideration in Work Plan preparation.

The vicinity of Red River is extensively and intensively used for recreation. All summer and winter recreation activities are available. The two most popular activities are fishing and skiing.

Between Questa and Red River the Molybdenum Corporation of America operates molybdenum mines and a reduction plant.

The entire watershed is in the Northern Rio Grande Resource Conservation and Development Project Area. Several project measures have been

completed to improve agricultural water management. The watershed is also within the Four-Corners Economic Development Region.

WATERSHED PROBLEMS AND NEEDS

Damaging floods occur two or three times a year. The recreation area and facilities in and near the community of Red River receive damage from floods coming from the steep canyons adjacent to the town. Several of the lodges and tourist courts are in the floodplain and are subject to extensive damage when high intensity rains occur on the upper portions of the watershed.

This watershed is intensively used by recreation seekers. Many more recreation areas are needed to provide for the ever increasing vacation load.

Streambank stabilization is needed along the Red River in many places particularly through the village of Red River.

Waste from the Molybdenum Corporation mine (mine and tailings ponds) need plans for revegetation.

PHOTO AII-1. RED RIVER, NEW MEXICO - A POPULAR RESORT AREA

SCS PHOTO 12-P392-15

There are also small areas (640 acres total) of a hydro thermal soil (chalky white material) that presently supports no vegetation. When these small areas erode, they give the Red River its milky appearance. Studies need to be made to determine what kinds of vegetation will stabilize these areas.

Damaging floods are usually caused by high-intensity thunderstorms during the summer months. Flooding also occurs when the snowpack is melted quickly by an unusually warm spring. These spring melts may also be accompanied by rain. Streambank stabilization is needed on Red River particularly through the village of Red River. The 100-year frequency flood would inundate about 100 acres of urban land.

Flood damages in the lower reaches of the watershed and around the town of Questa are included in this report. Agricultural water management is needed on all of the irrigated areas. Work is being done under the Northern Rio Grande Resource Conservation and Development Project to reorganize and rehabilitate the irrigation systems. More is being planned and designed.

PHYSICAL POTENTIAL FOR MEETING NEEDS

A reconnaissance of the damage area and flood source area indicated that suitable sites are available on which to construct floodwater and sediment detention dams. Adequate borrow material is lacking at site locations and may present problems. All of the sites examined are close to residential areas and are high-hazard sites. Several of the sites are in potential rock slide areas and may present problems during and after construction. This potential will be studied in more detail in early stages of planning.

The irrigation systems can be reorganized and rehabilitated without encountering any major problems. This work is being done under the resource conservation and development project and is not considered here as a part of a proposed Public Law 566 project.

LOCAL INTEREST IN PROJECT DEVELOPMENT

Several of the property owners in the damage area have requested assistance in planning and construction of works to protect them from damaging floods. These people are interested in a flood control project to reduce or eliminate flood damage and to enhance the recreational values of the area. There is some opposition to a project, but it is felt the opposition can be overcome by a well-organized information program.

With damage potential reduced, the recreational facilities can be expanded resulting in increased economic returns to the local people. At present, there is not a local organization that can assume the legal and financial responsibilities to carry out a project under Public Law 566.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment Measures

This watershed has no critical areas needing protection. Most land on the watershed is managed well. The usual good range management practices are needed. There may be a tendency for small ranch owners to overstock private ranges, however, this is not a big problem.

Land treatment needs represent a development potential more than a need for protection. It is recognized, however, that land treatment will aid in retarding runoff and will reduce erosion.

Structural Measures

From the reconnaissance of the area around Red River, it was determined that flood damage and potential damage occurs in six locations. Proposed structural measures for flood protection include five floodwater retarding structures and one floodwater diversion. The approximate location of these sites is shown on the Structure Location and Land Treatment Map, Red River Watershed, facing page AII-10. See Tables AII-3 through AII-6, pages AII-8 and AII-9. All flood control structures will be high-hazard class "c" structures.

NATURE AND ESTIMATE OF COSTS OF IMRPOVEMENT

From a field reconnaissance and study of United States Geological Survey 7.5 minute quadrangle maps of the area, it was determined that feasible sites exist at the selected locations. The drainage area above each proposed flood control structure was determined from the quadrangle map. Cost estimates of the proposed structures were determined from data obtained from the quadrangle maps and a minimum of field surveys. Unit cost for earth embankment to cover all costs except land rights and administration were obtained from a curve developed from costs of completed Public Law 566 watershed work plans where detailed cost estimates have been made. Total estimated cost of structural measures is $3,567,200 (Table AII-6, page AII-9).

It is assumed that the rehabilitation of the irrigation systems is readily justifiable and will be continued under the present program and project; therefore, no estimate of cost of works of improvement is made for this report.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

Damaging floods occur on an average of two or three times each year. Major fixed improvements such as homes, businesses, resort motels, roads and streets receive the most damage. (The values of these various improvements range from a few thousand dollars to well over $100,000).

It is estimated that the area flooded by the 100-year frequency storm is about 100 acres. This area is intensively used as a summer and winter resort area and a variety of recreational facilities are located here. The population is highly variable ranging from 500 to 5,000. After the structural works of improvement are installed, the 100-acre area will be protected from the 100-year frequency storm. The flood protection provided, along with other development potential, will result in approximately $228,600 average annual benefits. These benefits compare favorably with the average annual project cost, which is $199,900. This results in a benefit cost ratio of 1.1:1 (see Tables AII-8 and AII-9, page AII-10).

There are approximately 115 owners and operators of major fixed improvements in the watershed that will be directly benefited by the project. In addition, many other people will benefit from the increased participation in a wider variety of recreational activities. Benefits accruing to the general public include flood damage reduction to roads, bridges, streets, culverts, and public utilities.

RECOMMENDATIONS

It appears from the investigations made that a Public Law 566 project will be the best approach to provide flood control for the area.

The interested local people should submit an application for assistance under Public Law 566. This can be done through the local soil and water conservation district. They should also form an organization with authority to levy and collect taxes on real property; and, with authority of condemnation if necessary to obtain land easements and rights-of-way. The local organization must also be able to carry out the operation and maintenance of a project.

Because of its location and mountainous terrain, this watershed invites intensive use by the public. This potential use demands that a comprehensive land use plan be developed at the earliest possible time for the entire watershed. This should include plans for summer home site locations, relic areas, recreation areas, utilities (including transportation facilities), waste disposal, etc. Plans should include private and public lands.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Subject to the state water laws, one or more of the structures mentioned in this report may serve dual purposes. In addition to flood control, structures can be used for recreation. Site 4 might develop as a boating and fishing area. The other sites are in very steep terrain but could add to the fishing potential for the area.

TABLE AII-3. STRUCTURE DATA, RED RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classification
1	6.8	79	132,500	R/C conduit	8	R/C chute	1	12.5	c
2	10.2	87	216,230	"	8	"	1	21.0	"
3	5.5	90	264,890	"	8	"	1	9.0	"
4	23.7	85	418,371	"	20	"	1	45.0	"
5	4.8	85	179,110	"	8	"	1	7.0	"

TABLE AII-4. CHANNEL DATA, RED RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Channel Designation	Length of reach (100 Ft)	Watershed area (SqMi)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
FWD 1	26.4	0.4	200	15	3.1	3.0	8,500

TABLE AII-5. RESERVOIR STORAGE CAPACITY, RED RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate 1/ (AcFt/SqMi/Yr)
1	6.8	72	372	444	0.11
2	10.2	105	560	665	0.10
3	5.5	60	300	360	0.11
4	23.7	229	1,195	1,424	0.10
5	4.8	53	300	353	0.11

1/ Erosion rates in the watershed range up to 0.50 acre-feet/square mile/year.

TABLE AII-6. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, RED RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost				
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	Total Installation cost
Floodwater retarding structures: 1	$ 403,000	$ 161,000	$ 2,000	$ 200	$ 566,200
2	587,000	235,000	6,000	200	828,200
3	377,000	151,000	3,000	200	531,200
4	861,000	344,000	6,000	200	1,211,200
5	294,000	118,000	2,000	200	414,200
Floodwater diversion (1/2 mile)	7,000	4,000	5,000	200	16,200
TOTAL	$2,529,000	$1,013,000	$24,000	$1,200	$3,567,200

1/ Price base: 1969

TABLE AII-7. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, RED RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

	Estimated average annual damage		Damage reduction benefits
	Without project	With project	
Flood Damage (Urban)	$188,500	$19,000	$169,600
TOTAL	$188,500	$19,000	$169,600

1/ Based on adjusted normalized prices

TABLE AII-8. ANNUAL COST, RED RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Structural Measures	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Floodwater retarding structures 1	$ 30,600	$1,000	$31,600
2	44,800	1,500	46,300
3	28,700	1,000	29,700
4	65,500	2,000	67,500
5	22,400	1,000	23,400
Floodwater diversion	900	500	1,400
TOTAL	$192,900	$7,000	199,900

1/ Installation cost 1969 price base amortized for 100 years at 5-3/8 percent interest.
2/ Adjusted normalized prices.

TABLE AII-9. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, RED RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

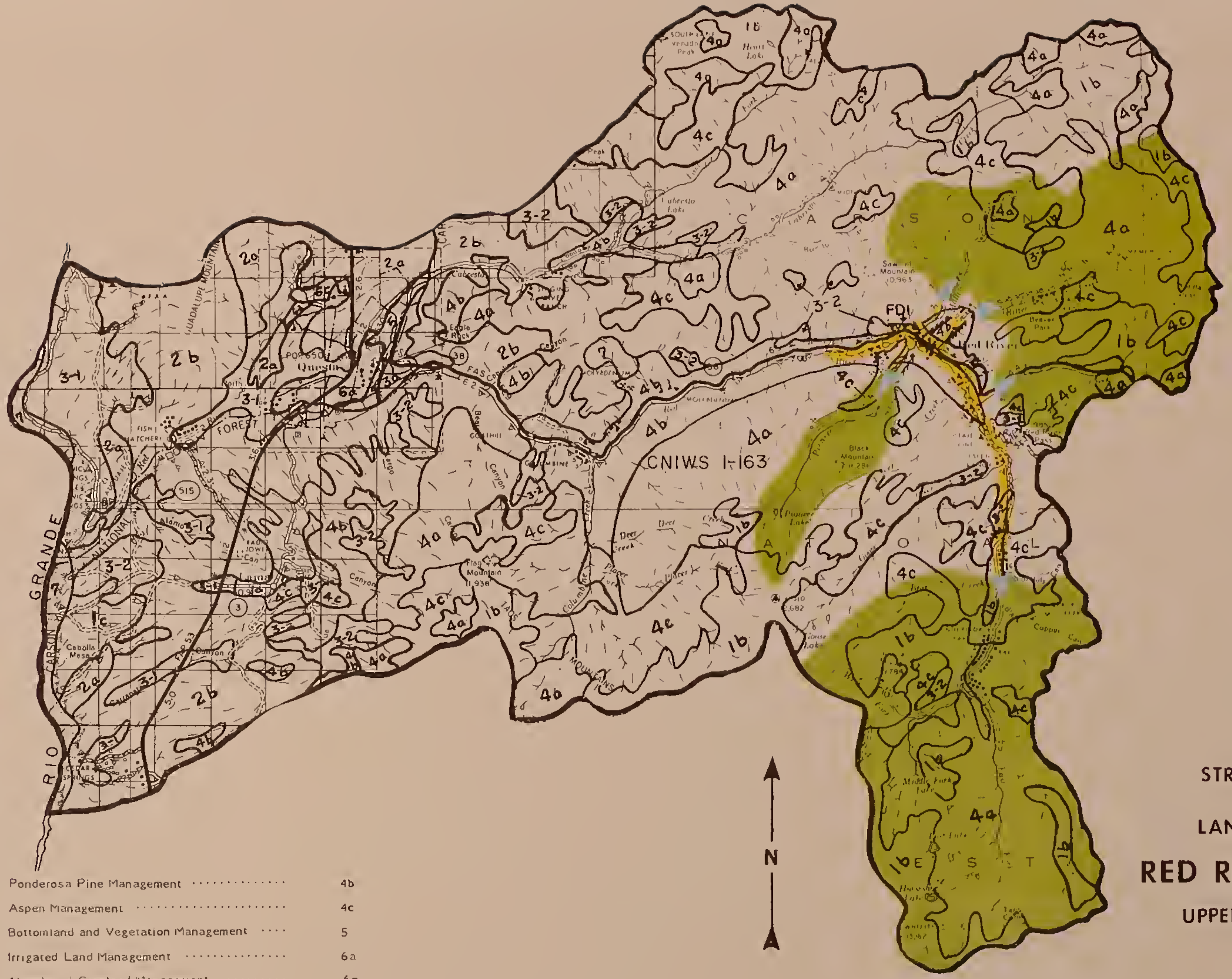
Evaluation Unit	Average Annual Benefits 1/				Aver. Annual COST 2/	Benefit Cost Ratio
	Damage Reduction	Redevelopment	Secondary	Total		
FRS - Sites 1, 2, 3, 4, and 5 and FWD	169,600	42,600	14,400	226,600	199,900	1.1:1

1/ Adjusted normalized prices.
2/ From Table AII-8

LEGEND

Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	22
Federal Highway Number	66
Site Number	
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Dam and Reservoir	
Floodwater Diversion	
Dikes or Levees (Existing)	
Outlet Channel	

Snowpack Management	1b	Ponderosa Pine Management	4b
Good Range Management	1c	Aspen Management	4c
Pinyon-Juniper Control	2a	Bottomland and Vegetation Management	5
Pinyon-Juniper Management	2b	Irrigated Land Management	6a
Sagebrush Control and Management	3-1	Abandoned Cropland Management	6c
Chaparral Control and Management	3-2	Miscellaneous Land	7
Spruce-Fir Management	4a		



STRUCTURE LOCATION
AND
LAND TREATMENT MAP

RED RIVER WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

2 0 2 4 MILES
SCALE 1:126,720

4-R-34705

USDA-SCS-FORT WORTH, TEX. 1975

EMBUDO RIVER WATERSHED
(CNI 1-151)
TAOS AND RIO ARRIBA COUNTIES, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is a tributary to the Rio Grande and is located in eastern Rio Arriba County and southeastern Taos County. Embudo River is the principal stream and enters the Rio Grande near the town of Embudo. Several other small towns are located in the watershed. The watershed is about 18 miles northeast of Espanola and 27 miles southwest of Taos. There are 204,770 acres (320 square miles) in the watershed. Eighty-one percent of the area is administered by federal agencies, 2 percent is state land, and 17 percent is private land.

The Embudo River Watershed lies in a mountainous area. Elevations range from 13,306 feet above mean sea level on North Truchas Peak to 5,800 feet where Embudo Creek enters the Rio Grande.

The average annual precipitation ranges from 10 inches at Dixon to 35 inches in the high mountains. The 35-year average flow of Embudo River at Dixon is 80.5 cubic feet per second.

The principal land use is for grazing livestock. Commercial timber and forest products are a minor contributor to the economy of the area. There are about 8,400 acres of irrigated land along the benches and in the valleys of the perennial streams. The irrigated areas range in elevation from about 5,800 to 8,000 feet above mean sea level. The principal crops grown are small grains, grass, hay, and pasture with some fruit and vegetables.

Approximately 245 square miles of this watershed is National Forest administered by the Forest Service. Seventy-four percent is classed commercial forest, 8 percent non-commercial forest, 1 percent as grassland, and 17 percent of the area is within the boundary of the Pecos Wilderness.

The Project Work Inventory lists needs for erosion control, vegetative manipulation, fuel treatment, and reforestation. These practices should be included in any work plan formulation for the watershed.

The watershed is located in the Espanola basin of the Southern Rocky Mountains physiographic province. It is underlain by sediments of the Ancha and Tesuque geologic formations of the Santa Fe Group.

PHOTO AII-2. 1967 FLOOD DAMAGE TO HIGHWAY AT DIXON BELOW PROPOSED SITE 1. SCS PHOTO 12-P576-2

WATERSHED PROBLEMS AND NEEDS

There are 41 community irrigation ditch systems serving the irrigated areas. A major problem in the watershed is the lack of sufficient water during the peak-use period for crops. This problem is caused by: (1) the inability of the irrigation systems to effectively deliver the low flows of the streams to the farm headgates; and (2) the interruption of irrigation service. This is caused by floodwater where ditches cross arroyos. Ditch breaks and sediment accumulations in the ditches are common during the irrigation season. Approximately 60 percent of the flood damage is to the irrigation systems and the loss of crop production from the interrupted water delivery. Floodwater damage to highways is high. Damages caused by washouts and sediment deposition are experienced annually in the vicinity of Dixon. Approximately 600 acres of floodplain lands would be inundated by the 100-year frequency flood.

The major needs of the watershed are to (1) consolidate, reorganize, and rehabilitate the irrigation systems; (2) construct floodwater retarding structures at selected locations; and (3) provide streamflow regulation. This will include diversion and water control structures and ditch lining. The flood damages can be reduced about 80 percent by the construction of six floodwater retarding structures in the lower reaches of the watershed. About 20 percent of the irrigated land needs drainage.

PHYSICAL POTENTIAL FOR MEETING NEEDS

The principal measure in the watershed to reduce the flood hazard and flood potential is management on federally administered land. Very few control structures have been installed.

Many of the landowners are cooperators with the local soil and water conservation district and are encouraged to apply applicable conservation measures.

The topography, soil, and geology of the watershed are generally favorable for structural measures to effectively solve much of the flooding problem. Field and map reconnaissance indicates suitable sites for retarding structures are available. There are no major physical limitations to improving the irrigation systems and the irrigation efficiency; however, some of the local water users appear to be unwilling to consolidate the irrigation ditches.

A structure located above Penasco could be installed for irrigation and recreation water storage.

LOCAL INTEREST IN PROJECT DEVELOPMENT

In December 1962, local sponsoring organizations submitted to the Secretary of Agriculture an application for assistance with a project under Public Law 566. In June 1964, a field examination and report were completed by the Soil Conservation Service. The examination concluded that some flood protection measures probably could be justified in connection with agricultural water management measures.

The Embudo Watershed Association has been formed by the local people, and they have expressed a willingness to participate financially in accordance with their capabilities and their share of the costs of a project. These costs will include obtaining easements and rights-of-way and performing necessary operation and maintenance of the structural measures.

In the Upper Dixon area the landowners have developed a plan (RC&D Project Measure No. 130) to reorganize and rehabilitate with control structures and canal lining the Acequia del Medio (community irrigation ditch).

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment Measures

The most critical land treatment area is the Cascajo-Rough Broken Land Soil Association that supports a scattered to dense stand of pinyon-juniper trees. This is a high-sediment producing area. Intensive grazing management (including limited livestock use or exclusion)

coupled with small gully control, selective thinning of pinyon-juniper on better soil-slope sites and reseeding disturbed areas would aid in reducing sediments delivered to structure sites downstream. About 20 percent of the woodlands on moderately deep soils and moderate slopes could be cleared and reseeded to forage-producing grasses.

About 20 percent of the irrigated land needs drainage of some kind, and 90 percent needs improved irrigation facilities. This will include ditch lining, land leveling, irrigation water management, and redesigned field irrigation systems. Much of the drainage problem can be alleviated by improved irrigation systems.

There is a good potential in this watershed for improved economy by growing Christmas trees. The land and the climate are favorable for this type of venture. There is also potential for landowners to lease part of their property to urban "summer home site" seekers. In order to entice these prospective lessees, the private property needs to be improved. This can be accomplished by controlling gullies, thinning pinyon-juniper trees, clearing willows, reseeding barren ground, and improving irrigation systems. (See Structure Location and Land Treatment Map, Embudo River Watershed, facing page AII-18).

Structural Measures

Structural measures considered for development in the watershed are:

1. Six flood prevention structures. The locations are shown on the Structure Location and Land Treatment Map, Embudo River Watershed. Approximately 2.5 percent of the watershed area is controlled by these structures. This will reduce flood damages in the immediate vicinity of the structures by approximately 80 percent. All floodwater retarding structures are high-hazard class "c" structures.

2. Irrigation system rehabilitation, water control structures, and ditch lining as needed for the approximately 8,400 acres of irrigated land.

3. Construct subsurface drainage systems with appurtenant structures on about 1,850 acres of irrigated land. (See Tables AII-10 through AII-12, pages AII-16 and AII-17, and Structure Location and Land Treatment Map, Embudo River Watershed.)

NATURE AND ESTIMATE OF COST OF IMPROVEMENTS

A field reconnaissance using U. S. Geological Survey 7.5 minute quadrangle maps was made of the possible floodwater retarding structure sites and the irrigation systems needing rehabilitation.

The cost for the floodwater retarding structures was made by estimating the quantity of earthfill required for a dam and using unit cost data

from completed watershed work plans where detailed cost estimates have been made in similar conditions in New Mexico. The principal items of work in the structures will be earthmoving, both excavation and embankment. The estimate of cost for irrigation facilities was based on a cost per acre of development as estimated for the RC&D Project Measure No. 130, improvement of Acequia del Medio. The major items in the proposed works would be permanent-type diversion dams and concrete lining. Estimated cost of subsurface drainage is based on costs of similar projects in other locations. The principal item of work in subsurface drainage will be excavation. Land rights, easements, and rights-of-way will not be a major problem or cost. There are no roads nor utilities that would have to be relocated as a result of the proposed improvements. Estimated installation cost of the structural measures is $1,432,200 (Table AII-12, page AII-17).

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

Damage reduction benefits evaluated will accrue almost entirely to flood damages sustained by public roads, ditch culverts, and related appurtenances. The major damage area is located where highways and other roads cross arroyos. Six floodwater retarding structures are planned that will provide a high degree of protection to the damage area. It is expected that flood damages will be reduced by about 80 percent. Floodwater damages without project conditions are estimated to be $46,400. Damage reduction benefits accruing to structural measures will be about $37,100 annually.

The annual equivalent cost of flood protection measures is $54,200, and when compared with flood prevention benefits of $53,000, will provide a benefit-cost ratio of 1:1.

Agricultural water management benefits resulting from rehabilitated irrigation systems will amount to approximately $62,000 annually and will accrue on about 8,400 acres of land presently under irrigation. There are about 1,250 farmers in the watershed who will be benefited by rehabilitation of the irrigation systems.

Structural measures for agricultural water management will have an annual cost of $26,600 and average annual benefits of $73,600. Comparison of these benefits and costs will yield a benefit-cost ratio of 2.8:1. (See Tables AII-14 and AII-15, page AII-18.) The overall benefit cost ratio for the project is 1.6:1.

ALTERNATE OR ADDITIONAL POSSIBILITIES

The U. S. Forest Service and the Bureau of Reclamation have investigated a potential dam site east of Penasco on Santa Barbara Creek. A dam in this location would provide recreation, streamflow regulation, and some floodwater prevention benefits.

TABLE AII-10. STRUCTURE DATA, EMBUDO RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway		Emergency Spillway		Max. surface area emerg. spill. level (Ac)	Struc. Classification
				Type	Release rate (csm)	Type	percent chance of use		
1	2.48	69	386,955	R/C conduit	8	R/C chute	1	39	c
2	1.53	49	138,209	"	8	"	1	12	"
3	1.76	48	78,519	"	8	"	1	17	"
4	1.10	53	126,407	"	8	"	1	12	"
5	0.14	35	34,154	"	20	"	1	7	"
6	0.74	44	124,773	"	15	"	1	8	"

TABLE AII-11. RESERVOIR STORAGE CAPACITY, EMBUDO RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Storage capacity planned			Sediment storage rate 1/ (AcFt/SqMi/Yr)
		Sediment (AcFt)	Detention (AcFt)	Total (AcFt)	
1	2.48	806	235	1,041	3.25
2	1.53	217	130	347	1.41
3	1.76	250	150	400	1.42
4	1.10	156	85	251	1.42
5	0.14	20	13	33	1.43
6	0.74	105	67	172	1.42

1/ Erosion rates in the watersheds range up to 5.0, or more, acre-feet/square mile/year.

TABLE AII-12. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, EMBUDO RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost: Construction	Installation Cost: Installation services	Installation Cost: Land, easements, & rights-of-way	Installation Cost: Administration of contracts	Total Installation cost
Floodwater retarding structures: 1	$239,000	$ 96,000	$2,000	$ 200	$ 260,960
2	110,000	44,000	2,000	200	120,460
3	72,000	29,000	1,000	200	79,720
4	108,000	43,000	1,000	200	111,170
5	56,000	23,000	1,000	200	52,430
6	96,000	38,000	1,000	200	109,750
Irrigation facilities	294,000	165,000	-	2,000	461,000
Subsurface drainage	5,000	3,000	-	-	8,000
TOTAL	$980,000	$441,000	$8,000	$3,200	$1,432,400

1/ Price base: 1969

TABLE AII-13. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, EMBUDO RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage: Without project	Estimated average annual damage: With project	Damage reduction benefits
Flood Damage (Agricultural)	$46,400	$9,300	$37,100

TABLE AII-14. ANNUAL COST, EMBUDO RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Structural Measures	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Floodwater retarding structures: 1	$18,200	$ 500	$17,900
2	8,400	500	8,600
3	5,500	500	5,800
4	8,200	400	8,300
5	4,300	200	4,300
6	7,300	200	7,200
Subtotal (Sites 1-6)	51,900	2,300	54,200
Irrigation and drainage facilities	24,900	1,700	26,600
TOTAL	$76,800	$4,000	$80,800

1/ Amortized at 5-3/8 percent interest for 100 years.
2/ Adjusted normalized prices

TABLE AII-15. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, EMBUDO RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Item	Average Annual Benefits 1/					Aver. Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	Irrigation	Redevelopment	Secondary	Total		
FRS - Sites 1-6	37,100	-	12,200	3,700	53,000	54,200	1:1
Irrigation System Improvement	-	62,000	5,400	6,200	73,600	26,600	2.8:1
TOTAL	37,100	62,000	17,600	9,900	126,600	80,800	1.6:1

1/ Adjusted normalized prices
2/ From Table AII-14

LEGEND
Watershed Boundary
County Boundary
Town
Drainage
Divided Highway
Paved Highway
Gravel Road
Unimproved Roads
Bridge
Railroad
Pipeline
Canal
Dwelling or Farm Unit
Business & Post Office
School
Church
Cemetery
Corral
Windmill
Spring
Conservation Needs Inventory Watershed No. 1-119
State Highway Number 22
Federal Highway Number 66
Site Number
Potential Floodwater Retarding Structure
Area Controlled
Area Benefited
Snowpack Management 1b
Good Range Management 1c
Pinyon-Juniper Control 2a
Pinyon-Juniper Management 2b
Chaparral Control and Management 3-2
Spruce-Fir Management 4a
Ponderosa Pine Management 4b
Aspen Management 4c
Irrigated Land Management 6a
Dry Land Management 6b
Abandoned Cropland Management 6c
Critical Erosion Area
N
RIO GRANDE
Embudo
Apodaca
Dixon
Rio Lucio
Chamizal
Penasco
Vadito
Picuris
Placitas
Rodarte
Llano Largo
Llano
Ojo Sarco
El Valle
Las Trampas
Santa Barbara
Tres Ritos
Jicarita Peak
CNI WS 1-151
2 0 2 4 MILES
SCALE 1:126,720
STRUCTURE LOCATION
AND
LAND TREATMENT MAP
EMBUDO RIVER WATERSHED
UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971
4-R-34706

POJOAQUE CREEK WATERSHED
(CNI 1-144)
SANTA FE COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The Pojoaque Creek Watershed is located in Santa Fe County, beginning approximately five miles north of the city of Santa Fe. The watershed has an area of about 153,555 acres (240 square miles) of which 201 square miles are covered by a Public Law 566 watershed application. This watershed is approximately 22 miles in length and ranges from about 11 miles wide in the upper reaches to about 6 miles wide in the lower part.

Mean sea level elevations range from about 12,600 feet in the mountains area to about 5,500 feet where Pojoaque Creek enters the Rio Grande. Major tributaries to Pojoaque Creek are the Rio Tesuque, Rio Nambe, Rio en Medio, Rio Chupedero, and Arroyo Seco. Arroyo Seco is not included in the PL-566 application.

The watershed is in the Southern Rocky Mountains Physiographic Province. The higher elevations are in the Southern Rocky Mountain Land Resource Area and most of the lower elevations are in the New Mexico Arizona Plateaus and Mesas Land Resource Area.

The average annual precipitation ranges from about 9 inches in the valley to more than 30 inches in the mountains.

The principal land use is for livestock grazing, with some timber land included and about 3,800 acres of irrigated land serviced by 45 ditches and 32 separate diversions. The principal crops grown on the irrigated land are alfalfa, small grains, corn, fruit, and vegetables.

Approximately 16 percent of the land is privately owned, 1 percent is state owned, 43 percent is federal land, and 40 percent is Indian land. This watershed includes about 45,000 acres of National Forest in the Tesuque District of the Santa Fe National Forest. Approximately 23,000 acres are classed as timberland; 11,000 acres as rangeland; and 11,000 acres are within the boundary of the Pecos Wilderness.

The 1959 preliminary work plan for this watershed presented a land treatment program for the National Forest, the need for which is certainly no less at present. The old program, with revisions and probable additions, should be considered in a new work plan formulation.

PHOTO AII-3. BRUSH CONTROL AND GRASS SEEDING ON NAMBE PUEBLO RANGE

SCS PHOTO 12-P303-1

The watershed is in the Northern Rio Grande Resource Conservation and Development area. Improvement is being made on some of the irrigation systems under this program.

WATERSHED PROBLEMS AND NEEDS

High intensity rains that occur from June through September fall on steep slopes with sparse vegetation and cause extensive gully development and frequent damaging floods. The major flood and sediment damage results from tributary flows that enter Pojoaque Creek. This damage includes washing out irrigation ditches, depositing sediment in ditches, crop damage from floodwater and sediment deposition, damage to canal headings and diversions from the streams, and damage to homes, businesses, and personal property. Sediment deposited in the stream channels is causing aggradation. This results in more frequent flooding of adjacent land.

Flood damage is sustained each year on the major tributaries and the main stem of Pojoaque Creek. Floods causing considerable damage occurred in 1951, 1952, 1954, 1955, 1957, 1958, 1963, and 1965. The largest flood occurred in 1955 and inundated 267 acres of cropland. The larger floods cause damage to State Highway 4, which parallels Pojoaque Creek as well as county and private roads. Private roads and crossings were damaged by small floods on Rio Nambe and Pojoaque Creek. Approximately 1,500 acres of the floodplain would be inundated by the 100-year frequency flood.

Erosion ranges from moderate to severe over all of the watershed except in the high mountain areas. The foothill area is the most severely eroded area in the watershed. Streambank erosion causes the damage to cropland through actual land loss. Floodwater retarding structures for flood protection and land treatment measures for sediment reduction and watershed protection are needed.

Shortages of water for irrigation during the growing season is a major problem in the watershed. This problem can be partially eliminated by a reorganization and rehabilitation of the distribution systems. Some streamflow regulation for irrigation is needed.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Very few flood prevention measures have been established within the watershed. There are a few locally effective erosion control and detention dams on Indian lands. Some streambank protection measures have been installed. Both are generally inadequate. Many of the landowners are cooperators with the local soil and water conservation district and are applying a few applicable conservation measures.

Field reconnaissance indicates that the topography, soils, and geology of the watershed are favorable for installation of structural measures that would effectively solve the problems caused by flooding. Many of the irrigation water management problems can also be solved. Sites for flood detention structures and outlet channels are available and adequate to solve much of the flood problem. Improved water management measures are stressed by the local soil and water conservation district. This can and is solving part of the problem.

There is a possible site location for a multiple purpose structure on Nambe Creek in which storage for recreation and irrigation in addition to flood prevention may be provided.

LOCAL INTEREST IN PROJECT DEVELOPMENT

An application for a Public Law 566 flood protection project was submitted in January 1955. A preliminary investigation and report were completed in March 1958. The project was determined to be economically unfeasible at that time. Further evaluation and preparation of a watershed work plan showed a favorable benefit-cost ratio. Because of opposition from landowners in the upper watershed, watershed planning assistance was terminated. Landowners in the Tesuque area have indicated an interest in being re-included in the project application since the floods during the summer of 1968. The Pojoaque Watershed District was legally reorganized in 1968 as a sub-district of the Santa Fe-Pojoaque Soil and Water Conservation District. This will meet the requirements for adequate local sponsorship of a Public Law 566 project.

Since the PL-566 work plan was terminated, interest has been shown by some local landowners to construct parts of the flood protection structures under other programs.

Local sponsors have indicated a willingness and a financial ability to assume their share of project costs. These costs will include obtaining easements and rights-of-way and performing necessary operation and maintenance of structural measures.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment Measures

Approximately 15 percent of the grasslands are in critical need of special erosion control and restoration practices. These areas are usually near farmsteads, cultivated fields and villages where pasturing animals overuse available forage.

Treatment will include exclusion or limited livestock use, small gully control, water spreading devices, grazing land mechanical treatment, and seeding to adapted grasses. Soil, climatic, and topographic conditions combine to make land treatment difficult in the lower reaches of this watershed. Areas of badlands should be treated to keep sediment eroding from them as close to the area as possible. Small gully plugs, net wire fences, contour furrows, diversions, and seeding treated areas are a few of the practices that can be employed.

Grazing management is needed on all areas. Most of the rangeland below the ponderosa pine line is suffering from overuse. Grazing systems including deferred grazing, rotation-deferred grazing and better livestock distribution through use of fencing and watering facilities are the main practices.

Additional land treatment measures are land leveling, ditch construction, rehabilitation and lining; water control structures, improved water management; and cover crops. (See Structure Location and Land Treatment Map, Pojoaque Creek Watershed, facing page AII-26).

Structural Measures for Flood Prevention

Twenty-two flood retarding structure sites were studied to determine feasibility. Of the sites investigated, three appear to be economically feasible under Public Law 566 criteria. (See Tables AII-16, AII-17, and AII-18, pages AII-24 and AII-25, and Structure Location and Land Treatment Map, Pojoaque Creek Watershed). The three sites that have an apparent favorable ratio would provide a fair degree of control for the total watershed area.

The Pojoaque Unit of the San Juan-Chama Project of the U. S. Bureau of Reclamation is within the watershed. The project will consist of a storage reservoir on Nambe Creek that will store about 1,500 acre-feet of water.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Investigation of the structure sites and damage of flooded areas was made by field and map reconnaissance with a minimum of field surveys. Both aerial photos and U. S. Geological Survey 7.5 minute quadrangle maps were used to outline flooded and contributing areas.

The costs for the construction and installation of floodwater retarding structures were estimated by curves developed by the watershed planning staff, which give structure cost versus drainage area controlled. The principal items of work will be earthfill. All structures will be high-hazard class "c" structures. Estimated installation cost of the structural measures is $3,046,100 (Table AII-18, page AII-25).

Land rights, easements, and rights-of-way will not be a major problem or cost. There are no roads or utilities that will have to be relocated as a result of the structures.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

The annual project cost for structural measures is $167,900, which includes $3,600 for operation and maintenance. When this cost is compared with estimated average annual benefits of $161,100, the benefit-cost ratio is 1:1 (see Table AII-20, page AII-26).

ALTERNATES OR ADDITIONAL POSSIBILITIES

The Nambe Creek structure planned by the Bureau of Reclamation has good possibilities for recreation in addition to irrigation and floodwater purposes.

The current PL-566 watershed application includes an area west of the Rio Grande. Protective measures for this area cannot be justified under PL-566 criteria; however, it is possible that some of the works needed can be provided under the Resource Conservation and Development Program or other programs.

TABLE AII-16. STRUCTURE DATA, POJOAQUE CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classi-fication
1	3.5	74	143,426	R/C conduit	12	R/C chute	1	19.5	c
2	10.3	93	367,466	"	8	"	1	35.0	"
3	13.3	62	211,836	"	8	"	1	54.0	"
4	1.4	36	132,319	"	12	"	1	13.5	"
7	4.9	38	279,889	"	10	"	1	52.0	"
10	2.6	40	78,967	"	12	"	1	70.0	"
11	10.7	45	222,515	"	8	"	1	77.0	"
12	5.3	37	141,432	"	10	"	1	45.0	"

TABLE AII-17. RESERVOIR STORAGE CAPACITY, POJOAQUE CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Storage Capacity Planned: Sediment (AcFt)	Storage Capacity Planned: Detention (AcFt)	Total Storage capacity (AcFt)	Sediment Storage rate 1/ (AcFt/SqMi/Yr)
1	3.5	213	273	486	0.61
2	10.3	546	685	1,231	0.53
3	13.3	652	861	1,513	0.50
4	1.4	72	125	197	0.51
7	4.9	260	370	630	0.53
10	2.6	139	220	359	0.53
11	10.7	567	787	1,354	0.53
12	5.3	281	413	694	0.52

1/ Erosion rates range as high as 4.0 acre-feet per square mile per year in the watershed.

TABLE AII-18. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, POJOAQUE CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost: Construction	Installation Cost: Installation services	Installation Cost: Land, easements, & rights-of-way	Installation Cost: Administration of contracts	Total Installation cost
Floodwater retarding structures: 1	$ 242,000	$ 97,000	$ 5,000	$ 200	$ 344,200
2	547,000	219,000	2,500	200	768,700
3	449,000	180,000	2,000	200	631,200
4	95,000	38,000	1,000	200	134,200
7	229,000	92,000	1,000	200	322,200
10	139,000	56,000	1,000	200	196,200
11	228,000	91,000	1,000	200	320,200
12	234,000	94,000	1,000	200	329,200
TOTAL	$2,163,000	$867,000	$14,500	$1,600	$3,046,100

1/ Price base: 1969

TABLE AII-19. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, POJOAQUE CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage: Without project	Estimated average annual damage: With project	Damage reduction benefits
Flood Damage	$176,000	$61,000	$115,000

1/ Based on adjusted normalized prices

TABLE AII-20. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, POJOAQUE CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Structures	Amortization of installation cost $ 1/	Av. annual operation & maintenance cost $ 2/	Average Annual Cost	Estimated average annual benefits $ 2/	Benefit-cost ratio
Sites 1, 2, 3, 4, 7, 10, 11, and 12	$164,600	$3,600	$167,900	$161,100	1.0:1

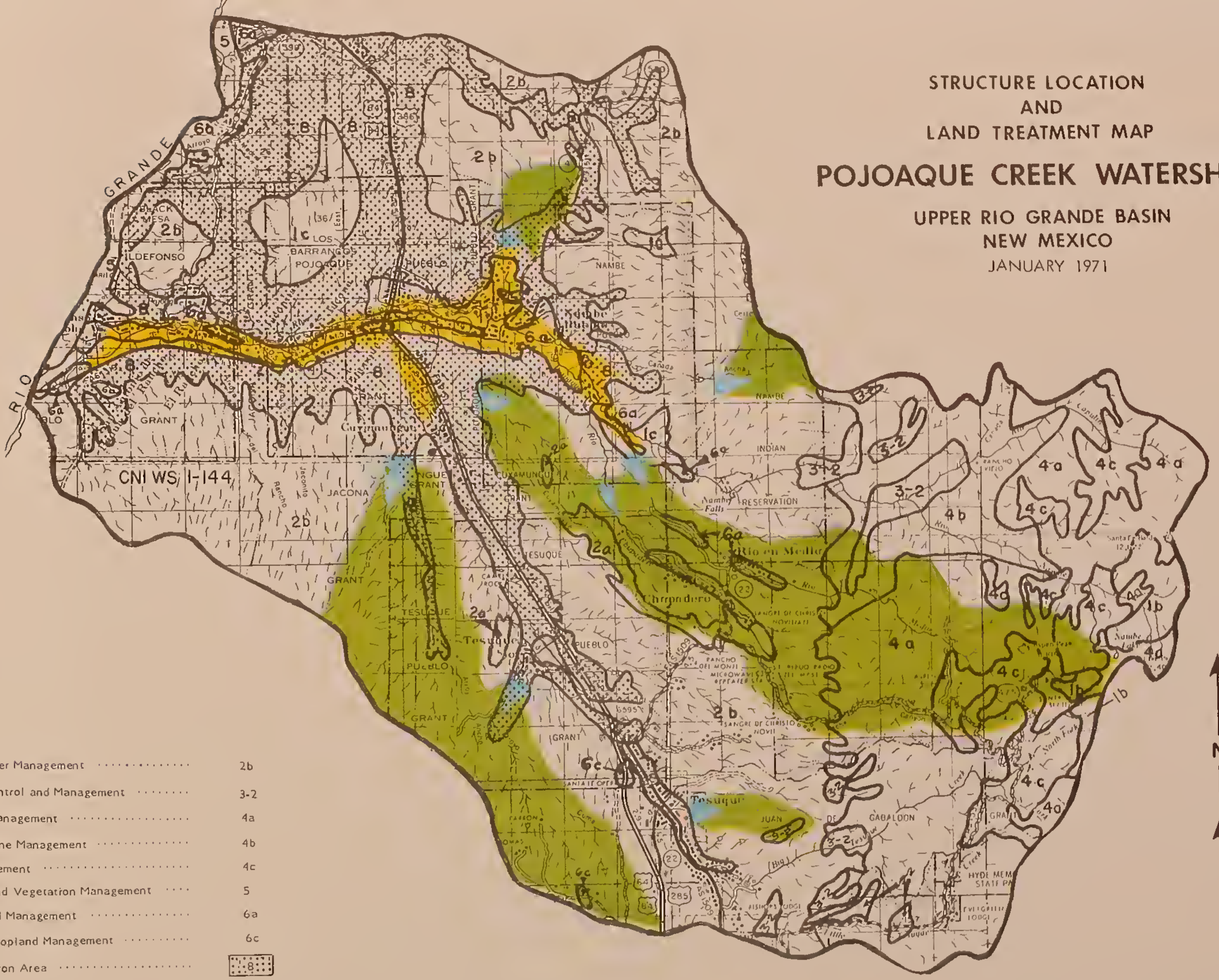
1/ Amortized at 5-3/8 percent interest for 100 years
2/ Adjusted normalized prices

STRUCTURE LOCATION AND LAND TREATMENT MAP

POJOAQUE CREEK WATERSHED

UPPER RIO GRANDE BASIN NEW MEXICO

JANUARY 1971



LEGEND

Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	22
Federal Highway Number	66
Site Number	
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Dam and Reservoir	
Proposed Reservoir	
Snowpack Management	1b
Good Range Management	1c
Pinyon-Juniper Control	2a
Pinyon-Juniper Management	2b
Chaparral Control and Management	3-2
Spruce-Fir Management	4a
Ponderosa Pine Management	4b
Aspen Management	4c
Bottomland and Vegetation Management	5
Irrigated Land Management	6a
Abandoned Cropland Management	6c
Critical Erosion Area	8

2 0 2 4 MILES

SCALE 1:126,720

4-R-34707

USDA SCS-FORT WORTH, TEX. 1971

SANTA FE RIVER WATERSHED
(CNI 1-140)
SANTA FE COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The Santa Fe River Watershed heads in the Sangre de Cristo Mountains at Lake Peak, elevation 12,409 feet above mean sea level, and drains in a southwesterly direction to the Rio Grande, elevation 5,200 feet above mean sea level. It is 36 miles long, 7 miles wide, and has an area of about 164,300 acres (257 square miles). The city of Santa Fe is located approximately in the center of the watershed. A State Enabling Act in 1930 and a 1932 cooperative agreement between the U. S. Department of Agriculture, the New Mexico Power Company, and the city of Santa Fe has excluded the upper one-fourth of the watershed from human use for the past 37 years. Except for well water, this area is the source of water for Santa Fe.

Approximately 46 percent of the land is privately owned, 12 percent is state, 40 percent is federal land, and about 2 percent is Indian land. The watershed is in the Northern Rio Grande Resource Conservation and Development Area. This watershed contains about 18,600 acres of National Forest and 12,300 acres of Title III land administered by the Tesuque Ranger District of the Santa Fe National Forest.

The upper portion, above Santa Fe is reserved as a municipal watershed and is in good to excellent condition. The lower portion (Title III) is pinyon-juniper and grassland much of which could benefit from vegetative manipulation and erosion control measures. Work plan preparation should consider these needs.

WATERSHED PROBLEMS AND NEEDS

A major problem in this watershed is floodwater and sediment damage in the city of Santa Fe. High intensity thunderstorms on the watershed near the city produce uncontrolled flooding that damages houses, businesses, streets, and bridges in urban areas. The 100-year frequency flood would inundate an estimated 100 acres of urban land in Santa Fe.

The problem has been intensified by the expansion of the urban areas into the pinyon-juniper woodlands north of town. The houses, patios, driveways, etc., have further increased the runoff from the area.

Two critical erosion areas demanding attention are located (1) on the north and east sides of the city of Santa Fe and (2) on the rangeland surrounding La Cienega community. Both of these areas are severely eroded and present problems to the residents and property owners. The

PHOTO AII-4. FLOOD DAMAGE FROM FLOOD OF JULY 25, 1968 AT 1133 E. ALAMEDA, SANTA FE SCS PHOTO 12-P784-3

principal area of urban expansion for Santa Fe has been in the pinyon-juniper covered hills on the north side of the city. The instability of soil materials associated with the Santa Fe geologic formation, the steep hills, and the disturbance of the area by building houses and roads and installing utilities, makes this area a high contributor of runoff water and sediment to lower elevations. The intensive network of roads and driveways together with the roofs, patios, and paved recreation areas have reduced the potential rainfall intake area by 15 to 25 percent.

In addition, urbanization has narrowed the stream channels through the city. A combination of the two factors results in floodwater and sediment damaged yards, buildings, and public utilities. To cope with these problems, a comprehensive combined land treatment and structural measure program is needed.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Some streambank protection measures have been installed through the city of Santa Fe and have been effective in preventing floodwater damage from minor storms. Field reconnaissance indicates that the topography and geology of the watershed are favorable for installation of structural measures. Adequate soil material at all sites is available for construction. Improved water management measures are stressed by the local soil and water conservation district. There are three structures upstream

from Santa Fe that were installed for storage of city water; however, there is no storage for flood protection provided in these structures.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The local people have high interest in installation of works for flood protection. The Corps of Engineers are in the process of making an investigation for flood protection in the city of Santa Fe. The majority of the damages are urban and the Corps of Engineers should be contacted and a statement of their interest in the project received before the Soil Conservation Service encourages an application for assistance under Public Law 566.

The Corps of Engineers has completed a floodplain study, which begins several blocks west of St. Francis Drive and extends downstream ten miles. A similar study has been made on Arroyo de los Chamisos and Arroyo Hondo.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

Homeowners can be encouraged to protect their property and their neighbors by building diversion structures, planting grass or other erosion control vegetation, thinning the pinyon-juniper brush and controlling small gullies. The property owners and the city need to cooperate on floodwater control and disposal of water from roads and driveways.

The area near La Cienega has suffered from heavy livestock use near the stream and farm headquarters. Limited livestock use, reseeding barren areas, control of small gullies, grazing land mechanical treatment and erosion control diversions are practices that can be employed to reduce the erosion.

About one-third of the pinyon-juniper woodland is adaptable to clearing and reseeding. A study of aerial photographs indicates the invasion of juniper brush on grasslands since 1935 has increased the total woodland area by 25 percent. This invasion is taking place on moderately deep to deep soils on slopes of less than 15 percent gradient. Approximately 4,000 acres of cholla control has been done on lands administered by the Forest Service. Invasion on grasslands by this plant is a problem on the western half of the watershed.

A small area of oak brush is located around McClure Reservoir and is a potential sediment source to the water impoundments. No plans for conversion to grass or other tree species are under consideration (see Structure Location and Land Treatment Map, Santa Fe River Watershed, facing page AII-34).

Structural Measures

The structural measures proposed include three single-purpose floodwater retarding structures and one multiple-purpose structure. The three single-purpose structures are on tributaries to the Santa Fe River. These proposed structures will effectively reduce the flow from the arroyos to a level that the existing river channel can discharge floodwaters without damage.

The proposed multiple-purpose structure (flood protection and municipal water storage) is to be incorporated into the existing Two-Mile Reservoir on the mainstem of the Santa Fe River operated for municipal water by the Public Service Company of New Mexico. The existing structure has a capacity of 406 acre-feet with a dam about 45 feet high. The dam, outlet works, and emergency spillway can be modified and enlarged to permit flood storage from the 100-year chance storm. The structure would also contain the expected sediment yield for 100 years and maintain the existing storage. The four structures will reduce flood flows so that the existing Santa Fe River channel will safely carry the outflow from all four proposed structures plus flows from the uncontrolled areas. At the time of field investigations, the city of Santa Fe was cleaning the vegetation growth and debris from the river channel. This type of channel maintenance is a requirement to maintain the capacity needed under future conditions with the project in place (see Tables AII-21, AII-22, and AII-23, pages AII-32 and AII-33, and Structure Location and Land Treatment Map, Santa Fe River Watershed, facing page AII-34).

NATURE AND ESTIMATE OF COST OF IMPROVEMENTS

The preliminary design and cost estimates for the proposed structures are of a reconnaissance level. They are based on a field inspection, data from aerial photos and U. S. Geological Survey quadrangle maps. The reservoir capacities and dam quantities were estimated from this data. The unit costs used to estimate the cost were taken from curves of costs and quantities from constructed projects and projects with detailed cost estimates prepared. The estimated installation cost of structural measures is $1,373,100.

Site 1, the Two-Mile Reservoir, is located on National Forest land. There are three old houses that must be moved. The other structure will be located in areas where potential housing development is likely. Therefore, it is anticipated that land rights will be relatively expensive. It is not anticipated that a problem will occur in acquiring land for structure locations.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

All floodwater damages and damage reduction benefits evaluated in this report accrue to the urban area of Santa Fe. The extent of economic investigations at this time did not reveal any agricultural damage.

Flood damage information obtained for the flood of August 1968 provided a benchmark for estimating other damages and preparation of a damage-frequency curve. Average annual urban damages without project conditions are estimated to be $57,000. Installation of structural measures is expected to provide a high degree of control of these damages, resulting in average annual damage reduction benefits of $56,000.

Redevelopment benefits associated with installation and maintenance of structural measures amount to $18,100 annually. These benefits will accrue to unemployed local labor, which will be utilized during installation of project measures and other employment needed for operation and maintenance purposes.

The value of local secondary benefits accruing to the project amount to $4,900. They result from increased production of goods and services made possible by the flood protection project.

Average annual project benefits are estimated to be $79,000, and when compared to annual equivalent costs of $78,400, will yield a benefit-cost ratio of 1:1 (see Tables AII-25 and AII-26, page AII-34).

ALTERNATE OR ADDITIONAL POSSIBILITIES

The Army Corps of Engineers has prepared a tentative plan of improvement consisting of channelization of both the Santa Fe River and Arroyo Mascaras. This plan was presented to local interests for their consideration. The main objection was the proposed channelization of the Santa Fe River through the city park area.

TABLE AII-21. STRUCTURE DATA, SANTA FE RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway		Emergency Spillway		Max. surface area emer. spill. level (Ac)	Struc. Classification
				Type	Release rate (csm)	Type	percent chance of use		
1	26.3	80	532,760	R/C conduit	8	R/C chute	1	45	c
2	1.9	64	135,400	"	20	"	1	15	"
3	1.9	45	131,500	"	20	"	1	25	"
4	1.0	37	48,200	"	20	"	1	13	"

TABLE AII-22. RESERVOIR STORAGE CAPACITY, SANTA FE RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Storage capacity planned				Total storage capacity (AcFt)	Sediment storage rate 1/ (AcFt/SqMi/Yr)
		Sediment (AcFt)	Detention (AcFt)	Subtotal flood prev. (AcFt)	Water Supply (AcFt)		
1	26.3	83	1,050	1,133	406	1,539	0.03
2	1.9	67	196	263	0	263	0.35
3	1.9	158	196	354	0	354	0.83
4	1.0	89	103	912	0	912	0.89

1/ Erosion rates in the watershed range as high as 2.0 acre-feet per square mile per year.

TABLE AII-23. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, SANTA FE RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost				Total Installation cost
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	
Two-Mile Reservoir Site 1	$586,000	$195,000	$15,000	$ 500	$ 796,500
Canada Ancha Site 2	167,000	67,000	10,000	200	244,200
Arroyo de la Piedra Site 3	137,000	55,000	10,000	200	202,200
Arroyo Barranca Site 4	86,000	34,000	10,000	200	130,200
TOTAL	$976,000	$351,000	$45,000	$1,100	$1,373,100

1/ Price base: 1969

TABLE AII-24. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, SANTA FE RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage		Damage reduction benefits
	Without project	With project	
Flood Damage (urban)	$57,000	$1,000	$56,000

1/ Based on adjusted normalized prices

TABLE AII-25. ANNUAL COST, SANTA FE RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

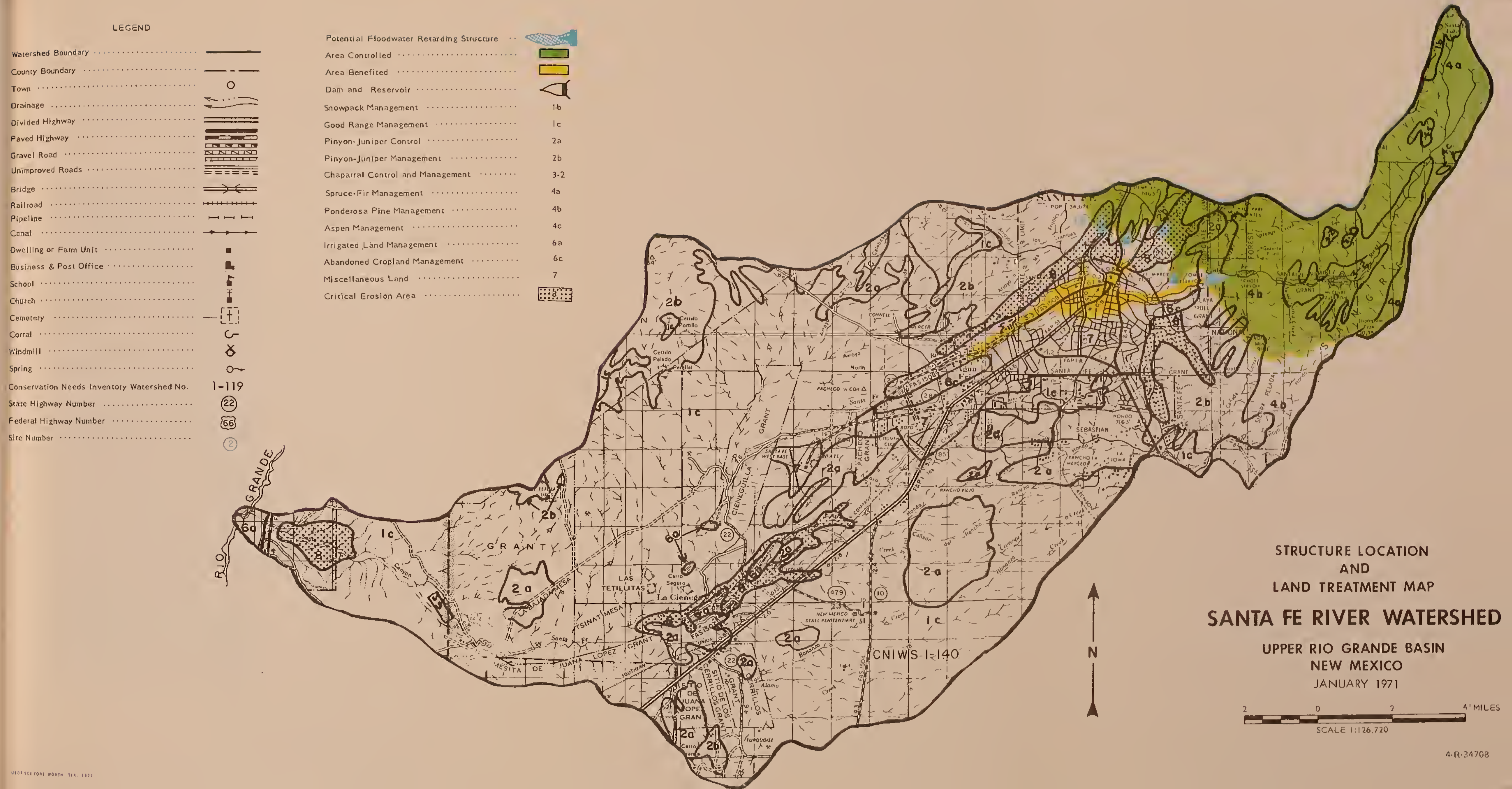
Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Floodwater retarding structures 1, 2, 3, 4 and 5	$74,200	$4,200	$78,400

1/ Amortized for 100 years at 5-3/8 percent interest.
2/ Adjusted normalized prices

TABLE AII-26. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, SANTA FE RIVER WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average Annual Benefits 1/				Aver. Annual Cost 2/	Benefit-cost ratio
	Damage Reduction	Redevelopment	Secondary	Total		
Floodwater retarding structures 1, 2, 3, 4 and 5	$56,000	$18,100	$4,900	$79,000	$78,400	1.0:1

1/ Adjusted normalized prices
2/ From Table AII-25


LEGEND
Watershed Boundary
County Boundary
Town
Drainage
Divided Highway
Paved Highway
Gravel Road
Unimproved Roads
Bridge
Railroad
Pipeline
Canal
Dwelling or Farm Unit
Business & Post Office
School
Church
Cemetery
Corral
Windmill
Spring
Conservation Needs Inventory Watershed No. 1-119
State Highway Number 22
Federal Highway Number 66
Site Number 2
Potential Floodwater Retarding Structure
Area Controlled
Area Benefited
Dam and Reservoir
Snowpack Management 1b
Good Range Management 1c
Pinyon-Juniper Control 2a
Pinyon-Juniper Management 2b
Chaparral Control and Management 3-2
Spruce-Fir Management 4a
Ponderosa Pine Management 4b
Aspen Management 4c
Irrigated Land Management 6a
Abandoned Cropland Management 6c
Miscellaneous Land 7
Critical Erosion Area 8
RIO GRANDE
GRANT
LAS TETILLITAS
La Cienega
CNIWS 1-140
SEBASTIAN
N
STRUCTURE LOCATION
AND
LAND TREATMENT MAP
SANTA FE RIVER WATERSHED
UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971
2 0 2 4 MILES
SCALE 1:126,720
4-R-34708

GALISTEO CREEK WATERSHED
(CNI 1-139)
SANTA FE AND SANDOVAL COUNTIES, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located about 30 miles north of Albuquerque. The total drainage area of the Galisteo Creek Watershed is 710 square miles, which is divided into three watersheds in the Conservation Needs Inventory. Of this total drainage area, 596 square miles will be controlled by a floodwater retarding structure, Galisteo Dam, which is under construction by the Army Corps of Engineers. This structure was authorized by Public Law 645 in 1960 and will control downstream damages caused by the Galisteo Creek. The structure is located in the middle of CNI watershed 1-139.

The drainage area of CNI 1-139 is 172,589 acres, or about 270 square miles, and is a tributary to the Rio Grande. About 112,407 acres are private land; 18,250 acres are state land; 16,972 acres are federal land; and 24,960 acres are Indian land.

The area that has a flood problem is only a portion of the total Galisteo drainage area and is located in the vicinity of Pena Blanca. The drainage area contributing to the flood problem is about four square miles.

Mean sea level elevations range from about 5,200 feet at the confluence of the Galisteo Creek with the Rio Grande, to about 10,500 feet in the Sangre de Cristo Mountains. The arroyos within the Galisteo Watershed drain to the west.

About 171,129 acres of the area are devoted to livestock production and 1,460 acres are used for irrigated cropland. The irrigated land is used mainly for the production of alfalfa and small grains. There are three communities within the watershed: Pena Blanca, Santo Domingo Pueblo, and Domingo.

The Atchison, Topeka and Santa Fe Railroad traverses the watershed. State Highway 22 and U. S. Highway 85 service communities within the watershed (see Structure Location and Land Treatment Map, Galisteo Creek Watershed, facing page AII-42).

The average annual precipitation is less than eight inches at Pena Blanca. The average annual temperature is about 49°F, with a low of 15 degrees below zero, and a high of 98°F. The evaporation rate is high.

The watershed is within the Four-Corners Economic Development Region.

WATERSHED PROBLEMS AND NEEDS

The primary problem of this watershed is damage from floodwater and sediment in the village of Pena Blanca and to the irrigated cropland, canals and ditches. High intensity summer thunderstorms swell arroyos with floodwater, which flows through Pena Blanca, damaging homes, businesses, yards, and irrigation facilities. Irrigation canals are filled with sediment and canals are broken by floodwater. These events ordinarily occur at the time of year when plant water requirements are highest. Interruption of service to irrigated land results in lost crops and reduced yields. On the two sites mentioned in this report, there are no definite channels to the river. Any floodwater that cannot be handled by the irrigation canal damages irrigated land below. The 100-year frequency flood will inundate approximately 300 acres of irrigated land.

To cope with these problems a comprehensive combined land treatment and structural measure program is needed.

PHYSICAL POTENTIAL FOR MEETING NEEDS

The average annual precipitation is about eight inches and the evaporation rate is high. For this reason any permanent storage of water is not considered feasible in the structures proposed. There are, however, many opportunities for building picnic and camping grounds along the Rio Grande channel.

The topography of the area lends itself very well to the installation of small floodwater retarding structures. The two structures proposed in this report are felt to be the least costly and will meet the needs. There are, however, other possible alternate structure sites.

There are no channels from the Cochiti Main Canal to the river. A system of outleting the principal spillway flow is to utilize the canal to a point where the flow can be outleted into a natural channel to the river.

The soil material available at the proposed structure sites has good construction qualities and will not present any problems for construction of a standard retarding structure. There is a sufficient quantity of the soil material in the immediate vicinity of each structure site to provide the needed fill for construction of the dams and needed channel.

Geologically the two sites are in the Santa Fe Group. There should be no problems with borrow or foundation at either site. The permeability in the channels and abutments will be checked before final design. Depth to cutoff (Santa Fe Group) in the channel may be as much as 30 feet.

LOCAL INTEREST IN PROJECT DEVELOPMENT

At the present time local interest in a flood prevention project is low. This lack of interest may be due to the people's confidence in several small flood control structures installed about ten years ago. It appears that these structures are short lived and under-sized for the degree of protection needed for the residential areas. Local interest and the need for a higher degree of protection may not be generated until damages actually occur sometime in the future. An organization with legal authorities to sponsor a Public Law 566 program would have to be established but at the present time there may be strong opposition to an organization of this type.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The most important land treatment system needed is good range management on all grazing land. Much of the watershed area has been subjected to overstocking. The Santo Domingo Pueblo land and the breaks along the Rio Grande and Galisteo Creek are critical erosion areas and need special methods to reduce erosion and restore the area to productive use. The treatment system includes the proper combination of the following practices: livestock exclusion or limited livestock use, small gully control, water spreading devices, grazing land mechanical treatment, fencing, intensive vegetation management (pinyon-juniper and brush control) and critical area seeding.

There are several old mining areas that need special revegetation programs to restore their potential as range or recreation and beautification areas. The area of Madrid is an example.

Approximately 30 percent of the pinyon-juniper woodland occupies moderately deep soils on slopes less than 15 percent. These areas are adaptable to pinyon-juniper clearing. About 1,250 acres of bottomland vegetation need treatment. All but 20 acres of the recommended treatment can be accomplished in conjunction with a drainage program along the Rio Grande. The result will be an increase in the acreage of productive cropland. Twenty acres need to be managed for recreation, wildlife protection, and streambank protection. A drainage program designed to lower the water table would allow farmers a wide selection of adaptable crops, and permit reclamation of several fields that have detrimental salt accumulation. Improved irrigation practices need to be initiated on approximately 85 percent of the irrigated land to insure

good irrigation water management. This can be accomplished under Public Law 46 programs (see Structure Location and Land Treatment Map, Galisteo Creek Watershed, facing page AII-42).

Structural Measures

From a reconnaissance of the watershed, two sites just east of Pena Blanca were selected that are suitable for providing flood protection to the town and to the agricultural land west of town. These structures will be single purpose flood control structures.

A proposed outlet for the principal spillway discharge for both sites is to empty into the Cochiti Main Canal, which will convey the water about one mile and outlet it into an existing channel to the river. This will require (1) two small structures into the canal, (2) enlarging the canal to accomodate the increased flow, and (3) a structure to control and outlet the floodwater to the river. For location of the proposed structural measures see Structure Location and Land Treatment Map, Galisteo Creek Watershed.

The two structures proposed on arroyos at Pena Blanca would be designed to store the 100-year sediment yield and flood runoff from a one-percent storm. The sites are high-hazard, class "c" sites.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENT

The structural data, capacities and quantities were developed after a field reconnaissance of the sites using U. S. Geological Survey 7.5 minute quadrangle maps. The canal enlargement and outlet structures are planned to discharge the flows from the principal spillway and from the area between the dam and the canal (see Tables AII-27 and AII-28, page AII-40 for detailed structure data).

The cost of the earthfill structures is based on a unit cost per cubic yard for the dam installation. The unit cost for earthwork was obtained from a data cost curve developed from costs and quantities from Public Law 566 watershed work plans where a detailed cost estimate has been made on structures of similar nature in New Mexico. The cost of the outlet channel is based on a unit cost per cubic yard of concrete for a size and type of structure suitable to control the flow. The unit cost is the current cost of reinforced concrete in the area. The unit cost used in estimating the cost of enlarging the canal is a value arrived at on the judgment of the engineer making the estimates.

The total cost of the proposed structural measures is estimated to be $229,900. The average annual cost of structural measures is $12,800, of which $12,400 is for installation and $400 is for operation and maintenance of the structures (see Table AII-31, page AII-42).

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

Pena Blanca is a small community located immediately below two small arroyos where a potential flood hazard exists. Projections for future home and business construction indicate there will be 30 to 40 units subject to flood damage. The future flood hazard will be increased when existing small sediment structures are filled or fail due to an intensive storm. The farmland below Pena Blanca is used for alfalfa, row crops, and orchards. The area subject to damage is about 200 acres.

Average annual floodwater damage to urban and agricultural improvements amounts to $11,700. Average annual damage reduction benefits are estimated to be $11,100. Other project benefits accruing to structural measures include redevelopment benefits in the amount of $2,800 and secondary benefits in the amount of $1,000. Total project benefits are estimated to be $14,900, and when compared to an average annual cost of $12,300, will provide a benefit-cost ratio of 1.2:1 (see Tables AII-30, AII-31, and AII-32, pages AII-41 and AII-42).

TABLE AII-27. STRUCTURE DATA, GALISTEO CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classification
1	0.8	23	42,253	R/C conduit	20	R/C chute	1	16	c
2	0.5	24	24,892	"	20	"	1	11	"

TABLE AII-28. RESERVOIR STORAGE CAPACITY, GALISTEO CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Storage Capacity Sediment (AcFt)	Storage Capacity Detention (AcFt)	Total Flood prevention (AcFt)	Additional storage cap. Available (AcFt)	Sediment storage rate 1/ (AcFt/SqMi/Yr)
1	0.8	60	43	103	-	0.75
2	0.5	41	27	68	-	0.82

1/ Erosion rates in the watershed range up to 1.0 acre-feet per square mile per year.

TABLE AII-29. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, GALISTEO CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost				
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	Installation cost
Floodwater retarding structures: 1	$ 95,000	$38,000	$2,500	$200	$135,700
2	56,000	22,000	2,000	200	80,200
Outlet works Sites 1 and 2	11,000	2,700	100	200	14,000
TOTAL	$162,000	$62,700	$4,600	$600	$229,900

1/ Price base: 1969

TABLE AII-30. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, GALISTEO CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage		Damage reduction benefits
	Without project	With project	
Flood Damage			
(Urban)	$ 8,300	$500	$7,800
(Agricultural)	2,000	100	1,900
Subtotal	10,300	600	9,700
(Indirect)	1,400	-	1,400
TOTAL	$11,700	$600	$11,100

1/ Based on adjusted normalized prices

TABLE AII-31. ANNUAL COST, GALISTEO CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Floodwater retarding structures Sites 1 and 2 and Outlet Works	$12,400	$400	$12,800

1/ Amortized at 5-3/8 percent interest for 100 years.
2/ Based on adjusted normalized prices.

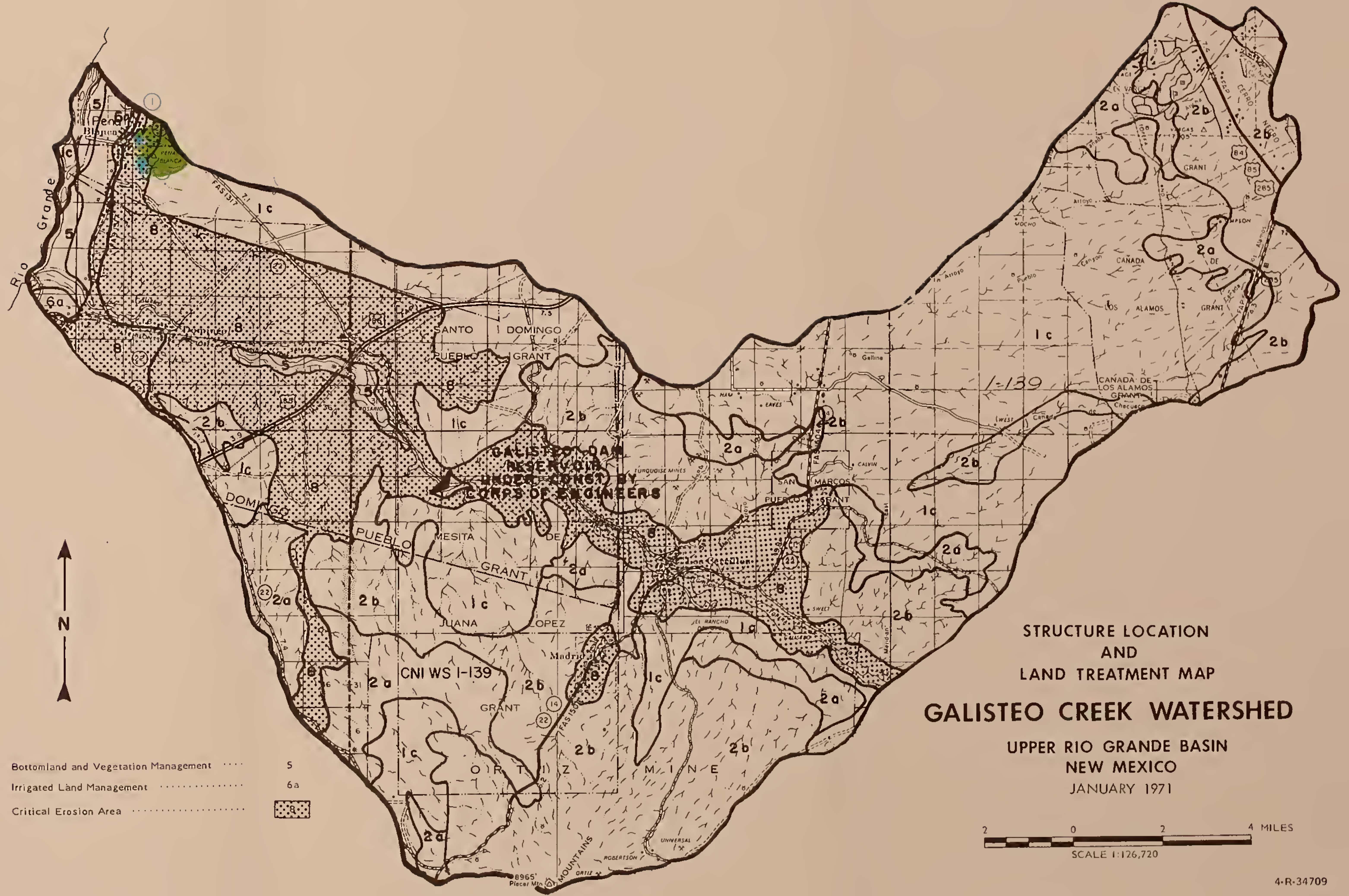
TABLE AII-32. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, GALISTEO CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average annual benefits 1/				Aver. Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	Redevelopment	Secondary	Total		
FRS - Sites 1, 2, and Outlet Works	$11,100	$2,800	$1,000	$14,900	$12,800	1.2:1

1/ Adjusted normalized prices
2/ From Table AII-31

LEGEND

- Watershed Boundary
- County Boundary
- Town
- Drainage
- Divided Highway
- Paved Highway
- Gravel Road
- Unimproved Roads
- Bridge
- Railroad
- Pipeline
- Canal
- Dwelling or Farm Unit
- Business & Post Office
- School
- Church
- Cemetery
- Corral
- Windmill
- Spring
- Irrigation Well
- Conservation Needs Inventory Watershed No. 1-119
- State Highway Number 22
- Federal Highway Number 66
- Site Number 2
- Potential Floodwater Retarding Structure
- Area Controlled
- Area Benefited
- Dam and Reservoir
- Floodwater Diversion
- Dikes or Levees (Existing)
- Outlet Channel
- Good Range Management 1c
- Pinyon-Juniper Control 2a
- Pinyon-Juniper Management 2b
- Bottomland and Vegetation Management 5
- Irrigated Land Management 6a
- Critical Erosion Area 8



STRUCTURE LOCATION AND LAND TREATMENT MAP

GALISTEO CREEK WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

2 0 2 4 MILES
SCALE 1:126,720

4-R-34709

USDA-SCS-FORT WORTH, TEX. 1971

RITO LECHE & NACIMIENTO WATERSHED (CNI 1e-12) SANDOVAL AND RIO ARRIBA COUNTIES, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located in Sandoval and Rio Arriba Counties, New Mexico. It is in the vicinity of Cuba, which is about 80 miles northwest of Albuquerque, New Mexico, on State Highway 44. The watershed has a drainage area of about 18 square miles, of which 50 percent is private land, and 50 percent is administered by the Forest Service.

The two main drainages in the watershed are the Rito Leche and Nacimiento Creek, which are tributaries to the Rio Puerco. The headwaters of the watershed are in the mountain range east of Cuba and drain in a westerly direction passing through Cuba and the surrounding irrigated land. They empty into the Rio Puerco Channel about two miles west of Cuba.

The population in Cuba is about 1,000. There are about 350 acres of irrigated cropland in the damage area of the watershed. This cropland is owned by about 50 operators. The cropland is devoted mostly to the production of alfalfa, small grains, grass or pasture, and gardens. The principal land use in the watershed is for grazing of livestock.

Mean sea level elevations range from about 6,900 feet at the confluence of Nacimiento Creek and Rio Puerco to about 10,000 feet in the mountains.

The watershed is in the Southern Rocky Mountain Land Resource Area. The average annual precipitation is about 12 inches at Cuba and 20 inches in the mountains. The average annual temperature is about 47°F with a high on record of 102°F and a low of minus 40°F.

The watershed is within the Four-Corners Economic Development Region.

The Cuba District of the Santa Fe National Forest administeres about 33,000 acres of this watershed. There are 11,000 acres within the San Pedro Parks Wilderness. Approximately 8,000 acres of the area outside the Wilderness are classed as commercial forest; 11,000 acres are noncommercial; and 3,000 acres are brushland.

PHOTO AII-5. FLOODPLAIN OF NACIMIENTO CREEK AND RITO LECHE, EAST OF CUBA, NEW MEXICO SCS PHOTO 12-P990-13

WATERSHED PROBLEMS AND NEEDS

High intensity rains, which occur from June through October, fall on steep slopes with sparse vegetative cover resulting in frequent damaging floods. Damaging floods occur on an average of once every three years. Major fixed improvements such as houses, businesses, motels, roads, and streets receive the most damage. Major floodwater and sediment damages are caused by overbank flooding of Rito Leche and Nacimiento Creek. Both of the channels through the damage area are so small that they overflow on the average of every two years.

The damaging storms that could be remembered by the local people occurred in 1958, 1963, and 1968. Information available on the flood of 1968 indicates damage to about 200 acres of irrigated cropland, 17 houses and businesses, 3 irrigation diversion headings, and State Highway 44. Traffic was held up for several hours due to flooding of the Highway.

Damaging floods occur on an average of once every three years. Major fixed improvements such as houses, businesses, roads, and streets receive most damage. The value of these improvements ranges from a few thousand dollars to well over $100,000.

It is estimated that the agricultural area flooded by the 100-year frequency storm is about 350 acres. This area is used mainly for

production of alfalfa, corn, irrigated pasture, and a small amount of vegetables. Agricultural damage amounts to an average of about $1,695 annually. The most significant flood hazard is the potential for damage in the urban area of Cuba. After future urban development and housing construction, average annual urban damage is estimated to be $54,805. Average annual indirect damages associated with flooding would be about $5,650.

Water-based recreation and storage of water for municipal use is needed. More intensive application of land treatment measures and better control of grazing and other flood prevention measures are also necessary. Approximately 10 percent of the watershed has critical erosion problems. Erosion rates range from moderate to severe, with the foothill areas being the most susceptible to erosion. Grazing management is needed on all areas, since most rangeland suffers from overuse. Twenty percent of the watershed is producing sagebrush and chaparral brush that need to be controlled. Eleven percent of the watershed is woodland growing on soil and slope conditions adaptable to control. Chaparral is not shown on the Land Treatment Map because it is intermingled with pinyon-juniper and ponderosa pine areas.

Cultivated land comprises two percent of the watershed, of which about 455 acres need improved irrigation systems. About 2,560 acres of this watershed are in the wilderness area and no land treatment is planned.

PHYSICAL POTENTIAL FOR MEETING NEEDS

There has been very little accomplished toward flood protection in the watershed. Some channel enlargement has been done on the Rito Leche, but it is inadequate.

Two floodwater retarding structures and two floodwater diversion sites were located, and it was determined that these structures were physically feasible and would meet the needs for flood protection. It is possible one of these structures could be a multiple-purpose structure including recreation and municipal water storage in addition to flood prevention.

The topography, soils, and geology at these sites are favorable for installation of the structural measures. Structure sites are located in the Kirtland Shale and Ojo Alamo Sandstone of Cretaceous age. All excavation would be common. Adequate clay and clayey sand is available for borrow. Cutoff depths into underlying shale would be less than 15 feet.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The local people are extremely interested in solving flood problems. In the past the people have asked for assistance, but until now the project did not appear feasible. The local people are willing to do everything

necessary to qualify for assistance under the Public Law 566 program. In addition to flood protection, the local people are interested in obtaining storage for recreation and municipal water.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watersned. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Systems include:

1. Pinyon-juniper control on 1,040 acres of woodland.
2. Sagebrush control on 1,630 acres of brushland.
3. Chaparral control on 250 acres of brushland.
4. Good management of 850 acres of ponderosa pine for commercial use.
5. Good management of 450 acres of aspen.
6. Phreatophyte control on 30 acres of land.
7. Improved irrigation facilities on 455 acres of irrigated land.
8. Good management of 350 acres of abandoned cropland.
9. Erosion control on 1,350 acres of critically eroded land. These areas are generally on steep, poorly vegetated, unstable soils and in heavily used areas near farmsteads and urban areas. Effective methods that may be used on areas subject to erosion are gully plugs, net wire fences, contour furrows, and diversions designed to stabilize the soils so grass seeding will result in protective stands of vegetation.

The National Forest Project Work Inventory lists vegetation control for enhancement of range and water yield, timber stand improvement for commercial forests, fuel control for forest protection and erosion control for land stabilization as needed on the watershed. All these needs should be considered when the project work plan is prepared.

Structural Measures

Reconnaissance of the watershed and discussion with local people indicate that flood damage occurs to the town of Cuba quite frequently. It has been determined that two floodwater retarding structures, one on Rito Leche, the other on Nacimiento Creek with an outlet channel, and two floodwater diversions would provide the needed flood protection for the town of Cuba. These measures would be single-purpose flood control structures.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Structural data was determined from U. S. Geological Survey quadrangle maps of the area and a centerline profile of the proposed floodwater retarding structures.

The major items of construction in the project would be earthwork and two stabilizing structures in the diversions. Floodwater Diversion 2 would cross State Highway 26 requiring a steel culvert.

The potential retarding structures and the pool areas on both structures would be located on land that is presently pasture, some of which is irrigated. The diversions would cross pasture land while the outlet channel for Site 1 and Floodwater Diversion 2 would follow the existing channel.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

It is estimated that the agricultural area flooded by the 100-year frequency storm is about 350 acres of land used mainly for the production of alfalfa, corn, and irrigated pasture. Agricultural flood damages are estimated to be $1,700 annually and would be reduced by about 90 percent with the installation of the project measures. This reduction would provide benefits in the amount of $1,500 per year. With the installation of structural measures for flood prevention, urban damage could be controlled resulting in $54,800 in average annual benefits and provide a high degree of flood protection to approximately 150 homes and business buildings in the town of Cuba. Indirect damages could be reduced by $5,700 to about $100 annually, yielding additional benefits of $5,600.

The sume of the above damage reduction benefits is $61,900. Other project benefits from redevelopment and secondary sources amount to $17,100 and, when added to damage reduction benefits of $61,900, provide a total of $79,600. When these benefits are compared to the annual equivalent cost of structural measures, a benefit-cost ratio to 1.3:1 is derived.

The land treatment systems suggested for this watershed are groups of interdependent measures. These systems are primarily designed to correct the dominant on-site problems of critical flood and sediment source areas.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatement systems are estimated to be $18,500. The average annual return is estimated to be $61,400.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Alternate structure locations are available for controlling the floodwater from the creeks and should be investigated when detailed plans are developed. It is possible that permanent storage could be provided for recreation, and municipal and industrial use.

TABLE AII-33. STRUCTURE DATA, RITO LECHE & NACIMIENTO WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Hgt. of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway Percent chance of use	Max. surface area emer. spil. level (Ac)	Struc. Class.
1	6.5	83	620,300	R/C conduit	8	R/C chute	1	80	c
2	6.9	74	416,500	"	8		1	61	c

TABLE AII-34. RESERVOIR STORAGE CAPACITY, RITO LECHE & NACIMIENTO WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Planned storage capac. Sediment (AcFt)	Planned storage capac. Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
1	6.5	294	698	992	0.45
2	6.9	316	742	1,058	0.46

TABLE AII-35. CHANNEL DATA, RITO LECHE & NACIMIENTO WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Designation	Length of reach (100 ft)	Watershed area (SqMi)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
FWD 1	45	0.6	500	40	3.0	4.9	23,000
FWD 2	30	0.25	270	20	2.7	4.0	21,300
Outlet channel for Site 1 and FWD 2	40	-	500	40	3.0	4.0	23,000

TABLE AII-36. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, RITO LECHE & NACIMIENTO WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost				Total Installation cost
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	
Floodwater retarding structures: 1	$383,000	$165,000	$19,500	$ 500	$ 568,000
2	284,000	122,000	19,500	500	426,000
Floodwater diversions					
1	22,000	10,000	500	500	33,000
2	13,000	6,000	500	500	20,000
Outlet channel	22,000	10,000	2,000	1,000	35,000
TOTAL	$724,000	$313,000	$42,000	$3,000	$1,082,000

1/ Price base: 1969

TABLE AII-37. ANNUAL COST, RITO LECHE & NACIMIENTO WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
FRS 1 and 2, and FWD 1 and 2, and outlet channels	$58,500	$2,700	$61,200

1/ Amortized at 5-3/8 percent interest for 100 years (rounded to nearest $10)
2/ Based on adjusted normalized prices.

TABLE AII-38. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, RITO LECHE & NACIMIENTO WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Flood Damage			
(Crop and Pasture)	$ 1,700	$200	$ 1,500
(Urban)	54,800	-	54,800
Subtotal	56,500	200	56,300
Indirect Damage	5,700	100	5,600
TOTAL	$62,200	300	$61,900

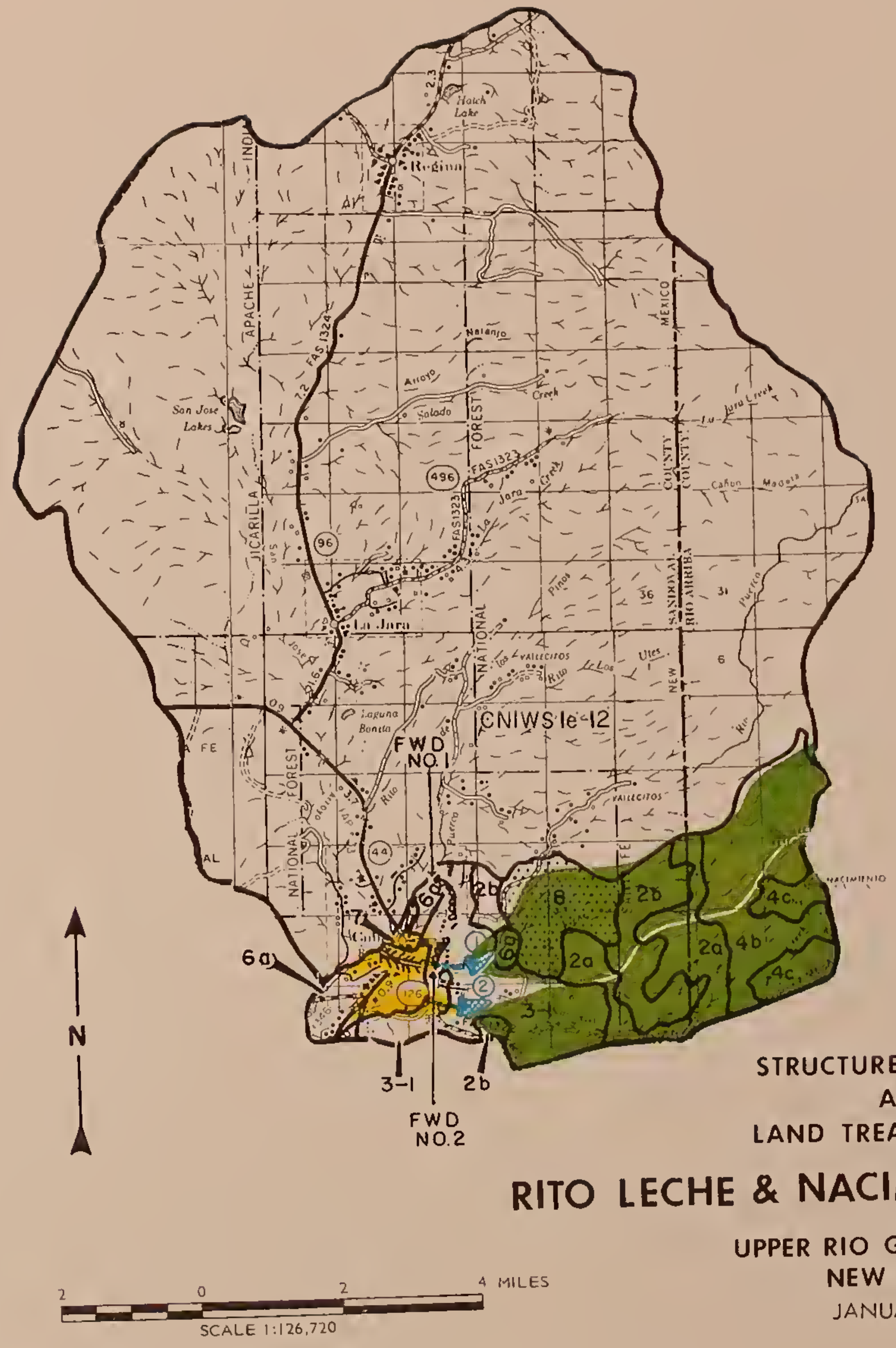
TABLE AII-39. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, RITO LECHE & NACIMIENTO WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average Annual Benefits 1/: Damage Reduction	Redevelopment	Secondary	Total	Aver. Annual Cost 2/	Benefit Cost Ratio
FRS 1 and 2, & FWD 1 and 2, & outlet channel	$61,900	$11,800	$5,900	$79,600	$61,200	1.3:1

1/ Adjusted normalized prices
2/ From Table AII-37.

LEGEND

- Watershed Boundary
- County Boundary
- Town
- Drainage
- Divided Highway
- Paved Highway
- Gravel Road
- Unimproved Roads
- Bridge
- Railroad
- Pipeline
- Canal
- Dwelling or Farm Unit
- Business & Post Office
- School
- Church
- Cemetery
- Corral
- Windmill
- Spring
- Irrigation Well
- Conservation Needs Inventory Watershed No. 1-119
- State Highway Number (22)
- Federal Highway Number (66)
- Site Number (2)
- Potential Floodwater Retarding Structure
- Area Controlled
- Area Benefited
- Stream Channel Improvement
- Floodwater Diversion
- Outlet Channel
- Pinyon-Juniper Control 2a
- Pinyon-Juniper Management 2b
- Sagebrush Control and Management 3-1
- Ponderosa Pine Management 4b
- Aspen Management 4c
- Irrigated Land Management 6a
- Miscellaneous Land 7
- Critical Erosion Area 8



STRUCTURE LOCATION
AND
LAND TREATMENT MAP

RITO LECHE & NACIMIENTO WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

4-R-34714

ROCK LAKE WATERSHED

(CNI 1-107)

TORRANCE COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located in Torrance County in central New Mexico. Willard, New Mexico, located 26 miles south of Moriarty and 10 miles south of Estancia, is in the watershed. This watershed drains in a northeasterly direction and is irregularly shaped. The north boundary of the watershed is one-half mile north of Willard and extends to the southwest about 23 miles to the divide between the Estancia and Rio Grande basins. The south boundary is about 11 miles south of Willard.

The watershed varies from about 12 miles wide in the middle to about 20 miles wide on the west side in the north-south direction and by about 24 miles long in the east-west direction. The total area of the watershed is about 156,000 acres or 244 square miles. There are 76,000 acres of grassland; 13,000 acres of brushland; 36,000 acres of woodland; and 31,000 acres of farmland, of which about 3,700 acres are irrigated.

The ownership of the watershed area is as follows: 19,000 acres administered by the federal government; 124,000 acres of private land; and 13,000 acres of land administered by the state.

Land administered by the federal government is under two separate agencies. The Bureau of Land Management administers 6,000 acres. The Forest Service administers 13,000 acres as part of the Cibola National Forest. Approximately 600 acres are classes as commercial forest; 7,800 acres as non-commercial; and 5,600 acres as grassland.

The Forest Service project work inventory lists needs for work to enhance range conditions and wildlife habitat, control erosion, improve timber stands, and recreation needs. These needs should be included in work plan preparation.

Three highways traverse the watershed. U. S. Highway 60 is located in the northern tip. New Mexico Highway 41 extends north to south in the center, and New Mexico Highway 42 begins at Willard and extends southeast. The Atchison, Topeka, and Santa Fe Railroad passes through the watershed. There are several county roads that make all portions of the watershed easily accessible.

Mean sea level elevations range from about 7,600 feet in the mesas west of Willard to about 6,100 feet in the valley. Topography in the watershed ranges from steep, rough mesa breaks to rolling plains and is

nearly level on the valley floor. The watershed is included in the Basin and Range Physiographic Province.

Climate in the valley is favorable to agriculture. The average annual temperature in the valley is about 50°F with a high of a little over 100°F and a low of around -33°F. Average annual precipitation ranges from as high as 30 inches in the mountains to about 10 inches in the valley. The average frost-free period is about 140 days from the middle of May to October. Average annual lake evaporation is about 60 inches.

Soils in the higher elevations are developing on nearly level to steep slopes in sandstone materials and mixed aeolian and alluvial materials on piedmont slopes. Soils range from shallow to deep and are represented by Steep Rocklands and Penistaja, Witt, Harvey, and Manzano soil series.

Soils in the vicinity of Willard are developing on level to gently sloping topography in terrace lake sediments and wind-deposited materials. They are generally of moderate depth and are represented by Willard, Ildefonso, and Karde soil series.

PHOTO AII-6. TYPICAL FLOODS IN ESTANCIA SUBBASIN. CORN DAMAGED BY FLOODS

SCS PHOTO 12-P573-3

There are two major land resource areas included in the watershed: (1) Arizona and New Mexico Mountains, and (2) Pecos-Canadian Plains and Valleys. The latter is very adaptable to irrigated crop production.

There are no perennial surface water streams. Groundwater is farily accessible for irrigation developments.

Drainages flowing from southwest to northeast cause substantial amounts of damage to land developed for irrigated crop production, farmsteads, fences, highways, and railroads. Floods in these draws are caused by high-intensity, short-duration rainstorms between May and October.

High-value crops such as lettuce, potatoes, and onions are well adapted to the area.

WATERSHED PROBLEMS AND NEEDS

Floodwater from the draws cause damage to high-developed irrigated cropland; irrigation wells; county roads; U. S. Highway 60; State Highway 41; the Atchison, Topeka, and Santa Fe Railroad; farm equipment, and farm homes.

Floods are caused by high-intensity, short-duration summer thunderstorms. Flood history obtained from the local people indicated that substantial damages are received about every two or three years. In 1967 a storm occurred over a portion of the watershed resulting in floodwater damage estimated at $40,000. The 1967 storm is estimated to be of the size that will occur on the average once every five years. The 100-year frequency storm would cause an estimated $400,000 damage, flooding an estimated 3,000 acres with an average depth of 2.0 feet.

The estimated average annual flood damage under future development without flood prevention measures installed is $95,500. The average annual damage to crop and pasture is estimated to be $68,000, and other agricultural damage is estimated to be $27,500. Other agricultural damage includes farm irrigation systems consisting of wells, pumps, and distribution systems; farm improvements; farm roads; and farm equipment. Damage to crops and pastures consists of actual loss, deterioration in quality, and the added expenses of harvesting and cleaning up of debris.

The Estancia Valley groundwater table has lowered. From 1948 through 1965 the water table declined about five feet.

The needs include flood protection, water-based recreation, groundwater recharge, grazing land management, and an improvement in the vegetative cover. Additional studies will be needed to determine the effects of artificial recharge on water quality.

PHYSICAL POTENTIAL FOR MEETING THE NEEDS

The topography, soils, and foundation conditions at the potential structure site locations do not lend themselves to large permanent water storage pools. Except for some incidental recreational benefits realized as the flood pool is drawing down, water-based recreation needs will have to be satisfied elsewhere.

Land treatment measures could be installed that would tend to increase cover, decrease runoff and sediment production, and increase groundwater recharge. The average annual rainfall, soils, topography, and climate in this area make it possible to attain a high degree of sediment control with land treatment; however, due to the high-intensity rainfall and subsequent high runoff, the land treatment alone will not control floodwater.

Along with the land treatment program, a flood protection project would be installed to control the floodwater. Potential floodwater retarding structure sites have been tentatively located. The topography does not lend itself well to retarding structures.

Available geologic information indicates floodwater retarding structures could be installed without exceptionally high structure cost on valley fill material of sand, clay, and gravel of Pliocene to Recent age. Abutment materials at all potential structure sites are erodable. Good material for construction of the earthfills is available. Soil material at potential structure sites are SM, SP, and SC. Gross erosion rates in the watershed range from 0.09 to 0.31 acre-feet/square mile/year and yield to reservoirs is 0.08 acre-feet/square mile/year.

Permeability at the potential structure sites and down the channels below the sites indicates the possibility of disposal of floodwater by recharging the groundwater aquifer instead of providing stable channels all the way to the salt lakes. It is assumed from available information that this is the most logical way to take care of the principal spillway discharge from the potential retarding structures.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The local people are aware of the existing flood hazard and are somewhat anxious to take measures to reduce or prevent this damage.

It is recommended that the local people obtain information necessary to form a legal sponsoring organization and pursue assistance from all available state and federal programs.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Systems include:

1. Protection from critical erosion on 1,000 acres. These areas are generally on steep, poorly vegetated, unstable soils, and along roads and trails. These severely eroded areas can benefit from the use of small gully plugs, net wire fences, contour furrows, and diversion designed to stabilize the soils so grass seeding will result in protective stands of vegetation.
2. Grazing management - good range management is essential on 6,000 acres of grassland. On all rangeland effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through use of additional fences and livestock watering facilities.
3. Brush control on 1,000 acres of sagebrush and 3,000 acres of yucca.
4. Pinyon-juniper control on 18,000 acres of woodland growing on soil and slope conditions adaptable to control.
5. Improved irrigation systems on 2,000 acres of irrigated land.
6. Dry cropland treatment on 1,000 acres.
7. Revegetation of 9,000 acres of poorly vegetated, formerly cropped fields. Many old dry cropland fields reseeded under the Conservation Reserve Program failed to respond with adequate stands of desirable grasses that would provide protection from wind and water erosion.

Structural Measures

Potential structural measures within the watershed are floodwater retarding structures on Round Top and Tabet Draws. The principal spillway discharges from these potential structures could be spread on the rangeland until absorbed, thereby serving as groundwater recnarge. This can be done at very little cost, and is the most economical and logical method of disposing of the principal spillway flow. However, in the event diversion works are needed to accomplish the desired recharge, a water right to appropriate and use surface water will be required.

The potential structures are single-purpose flood prevention measures with incidental agricultural water management benefits from the groundwater recharge. The potential structures are all classed as "c" high-hazard sites and concrete-chute emergency spillways are assumed necessary. (See Tables AII-40 and AII-41, page AII-58 for structural details.

and Structure Location and Land Treatment Map, Rock Lake Watershed, facing page AII-60 for structure locations).

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Potential structures were located on U. S. Geological Survey 15 minute quadrangle sheets. A stage storage curve was developed for each potential floodwater retarding structure to obtain an estimated height of structure. A centerline profile was taken off of the quadrangle sheet by interpolation between contour lines (20 foot contours). The required storage is based on the estimated 100-year sediment yield and the runoff produced by the 100-year frequency storm routed through the structure. With this information, estimated cubic yards of earthfill for a proposed dam was developed.

Cost estimates on the potential floodwater retarding structures were based on a cost per cubic yard of earthfill as determined by the lowest five bids on New Mexico's latest Public Law 566 contract. Cost for the concrete chute emergency spillway was based on estimates made for similar dam heights and drainage areas in planning. A 20 percent contingency figure was added to construction cost estimates to offset unforeseen costs of the structural measures. Other costs were estimated by using cost data from other watersheds with similar conditions.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

The estimated average annual flood damage in the watershed after the potential project is installed is $9,500. This is a reduction of approximately $86,000 or 90 percent by the installation of the project.

Redevelopment benefits from the installation of the project and operation and maintenance of project facilities would accrue. Local labor, not presently employed or not employed fulltime, could be employed in the installation and maintenance of project measures. The average annual value of redevelopment benefits is estimated to be $35,300.

Groundwater recharge will occur as a result of the potential floodwater retarding structures and associated works of improvement. The monetary value of increasing the recharge to the underground basin is estimated to be $34,600 when converted to an average annual value.

Secondary benefits resulting from the project will include increased net income to producers, handlers, and processors of increased agricultural production in the watershed. The estimated average annual secondary benefits are $11,200.

Total average annual benefits are estimated to be $168,800 (Table AII-45, page AII-60). The estimated average annual cost of the structural measures is $148,100. This results in a benefit-cost ratio of 1.1:1 (see Table AII-45).

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. Quality of runoff water will be improved. The systems will contribute to the improvement, development, and preservation of all watershed resources and their optimum utilization.

Total average annual costs for the land treatment system are estimated to be $77,200. The average annual returns are estimated to be $152,000.

ALTERNATIVE OR ADDITIONAL POSSIBILITIES

There are other potential structure site locations within this watershed. Such locations exist on the draws on which structure sites have been located.

There are other methods of handling the principal spillway discharge from the structures: (1) concrete-lined channel to deliver the flow below the railroad and highway. This alternative was investigated and it appeared to be the most expensive method of disposal. (2) Artificial recharge wells might be a possibility. This was investigated to obtain a rough cost estimate and would be possible if necessary. A thorough investigation of the water treatment would need to be made since the injected water would have to meet State Health Department requirements.

TABLE AII-40. STRUCTURE DATA, ROCK LAKE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emerge. spill. level (Ac)	Struc. Classification
1	14.0	43	510,000	R/C conduit	8	R/C chute	1	130	c
2	79.6	74	1,100,000	"	8	"	1	500	"

TABLE AII-41. RESERVOIR STORAGE CAPACITY, ROCK LAKE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Planned storage capacity		Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
		Sediment (AcFt)	Detention (AcFt)		
1	14.0	105	1,480	1,585	0.08
2	76.6	565	7,000	7,565	0.07

TABLE AII-42. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, ROCK LAKE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost: Construction	Installation Cost: Installation services	Installation Cost: Land, easements, & rights-of-way	Installation Cost: Administration of contracts	Total Installation cost
Site 1	$ 660,600	$ 99,100	$11,000	$300	$ 771,000
Site 2	1,504,800	180,600	25,000	600	1,711,000
TOTAL	$2,165,400	$279,700	$36,000	$900	$2,482,000

1/ Price base: 1969

TABLE AII-43. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, ROCK LAKE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage: without project	Estimated average annual damage: with project	Damage reduction benefits
Crop and pasture	$68,000	$6,800	$61,200
Other agricultural	27,500	2,700	24,800
TOTAL	$95,500	$9,500	$86,000

1/ Based on adjusted normalized prices

TABLE AII-44. ANNUAL COST, ROCK LAKE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

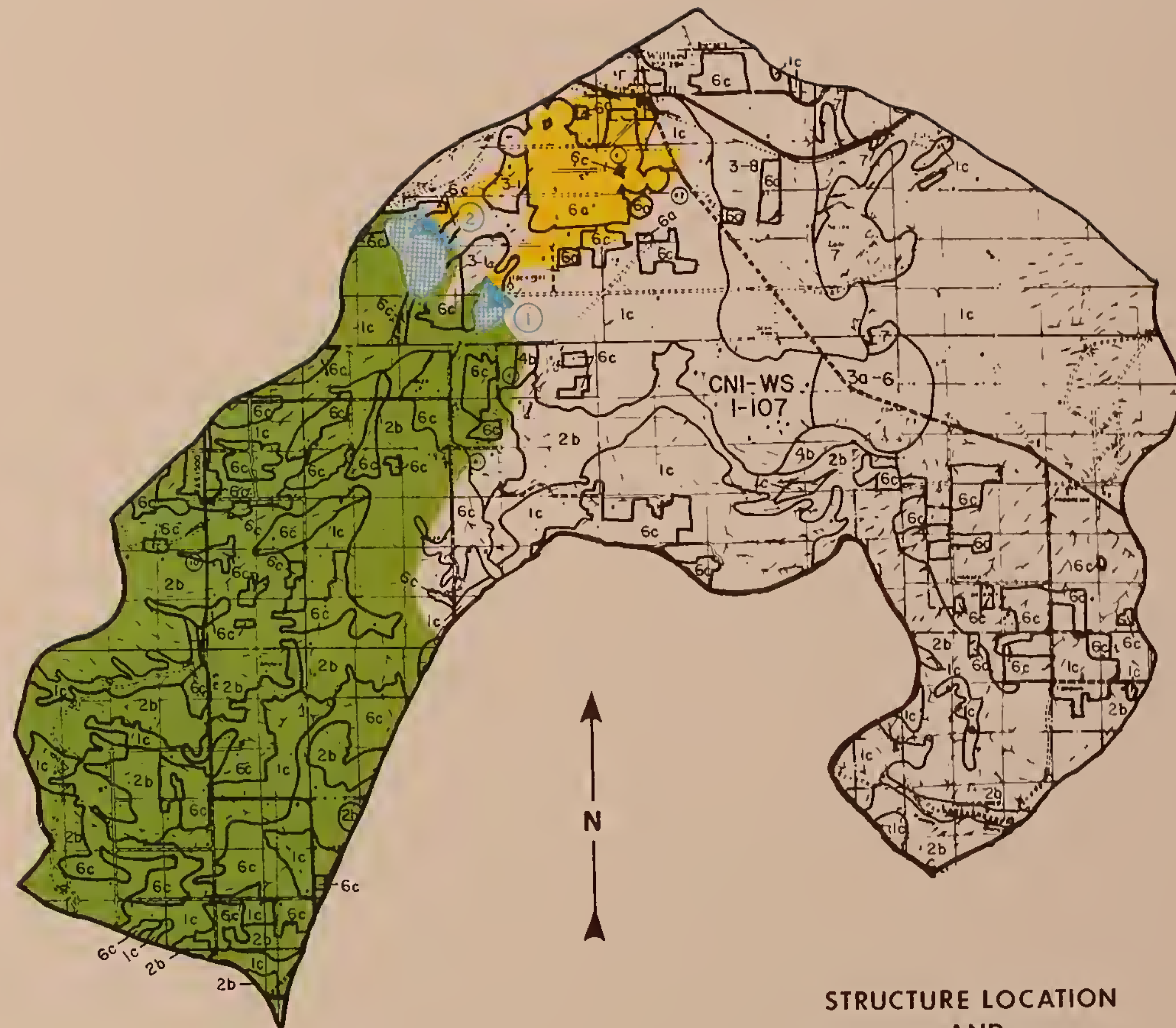
Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
All structural measures	$134,100	$14,000	$148,100

1/ Amortized for 100 years at 5-3/8 percent interest.
2/ Adjusted normalized prices

TABLE AII-45. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, ROCK LAKE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average Annual Benefits 1/					Aver. Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	Ground-water recharge	Re-devel-opment	Secon-dary	Total		
All structural measures	$86,000	$34,600	$37,000	$11,200	$168,800	$148,100	1.1:1

1/ Adjusted normalized prices
2/ From Table AII-44



LEGEND

- Watershed Boundary
- County Boundary
- Town
- Drainage
- Divided Highway
- Paved Highway
- Gravel Road
- Unimproved Roads
- Bridge
- Railroad
- Pipeline
- Canal
- Dwelling or Farm Unit
- Business & Post Office
- School
- Church
- Cemetery
- Corral
- Windmill
- Spring
- Irrigation Well
- Conservation Needs Inventory Watershed No. · 1-119
- State Highway Number · 22
- Federal Highway Number · 66
- Site Number · 2
- Potential Floodwater Retarding Structure
- Area Controlled
- Area Benefited

Good Range Management	1c
Pinyon-Juniper Management	2b
Sagebrush Control and Management	3-1
Yucca Control	3a-6
Fourwing Saltbush Management	3-8
Ponderosa Pine Management	4b
Irrigated Land Management	6a
Abandoned Cropland Management	6c
Miscellaneous Land	7

STRUCTURE LOCATION AND LAND TREATMENT MAP

ROCK LAKE WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

1 0 1 2 3 4 5 MILES

SCALE 1:190,000

4-R-34715

USDA-SCS-FORT WORTH, TEX. 1975

TAJIQUE WATERSHED
(CNI 1-114)
TORRANCE COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located in Torrance County in central New Mexico. It drains part of the east side of the Manzano Mountains in an easterly direction. The north boundary of the watershed is about ten miles north of Willard and extends to the west into the Manzano Mountains, which form the western boundary of the watershed. The south boundary of the watershed is about five miles north of Willard and the east boundary is parallel to and five miles east of State Highway 41.

The watershed averages about 6 miles wide, north to south, by about 24 miles long, east to west. The total area of the watershed is 98,600 acres or 154 square miles, of which 29,600 acres are grassland, 16,000 acres are brushland, 11,000 acres are woodland, 20,000 acres are timberland, and 22,000 acres are farmland. There are 5,000 acres of irrigated farmland.

The ownership of the watershed is as follows: 26,600 acres administered by the federal government; 70,600 acres of private land; and 1,400 acres of land administered by the state.

Land administered by the federal government is under two separate agencies. The Bureau of Land Management administers about 1,000 acres. The 26,000 acres of National Forest, Mountainair District of the Cibola National Forest, is classed as follows: 9,000 acres commercial; 15,400 acres non-commercial forest; and 1,200 acres grassland.

The Forest Service project work inventory lists projects designed to control erosion, enhance range conditions, improve efficiency of water use, and to improve timber stands, all of which should be considered in work plan preparation.

The town of Tajique is located within the watershed. It is about 23 miles southwest of Moriarty, which is 30 miles east of Albuquerque. State Highway 41 extends north and south through the eastern part and State Highway 10 traverses the western part of the watershed.

There is a spur from the Atchison, Topeka, and Santa Fe Railroad, which extends through the watershed to Moriarty. There are several county roads that make all portions of the watershed easily accessible.

Mean sea level elevations range from about 9,375 feet at Capilla Peak in the Manzano Mountains to about 6,100 feet in the valley. Topography in

the watershed ranges from steep, rough mountains to rolling plains and is essentially flat on the valley floor. The watershed is included in the Basin and Range Physiographic Province.

Climate in the valley is favorable to agriculture. The average annual temperature is 48°F at Tajique with a high of about 96°F and a low of about -21°F. The average temperature in the valley is about 50°F. Average annual precipitation is about 19 inches at Tajique to 10 inches in the valley. Average frost-free period is about 136 days from May 20 to October 3. Average annual gross lake evaporation is about 55 inches in the valley.

Soils in the mountains and foothills are developing on gently sloping to very steep slopes of limestone, sandstone, and shale materials. Depths range from shallow to deep. Wilcoxson, Supervisor, Pino and Turkey Springs soil series are represented. Soils below the foothills on valley-fill slopes and piedmont fans are developing on nearly level to strongly sloping topography in mixed alluvial deposits. They are moderately deep to deep and are represented by Witt, Harvey, and Manzano soil series. Soils in the vicinity of Estancia are developing on level to gently sloping topography in terrace lake sediments and wind-deposited soil materials. They are moderately deep and are represented by Willard, Ildefonso, and Karde soil series.

There are two major land resource areas included in the watershed: (1) Arizona and New Mexico Mountains, and (2) Pecos-Canadian Plains and Valleys. The latter is very adaptable to irrigated crop production.

There are no perennial surface water streams; however, groundwater is fairly accessible. It is necessary to rely upon groundwater for any developments using large quantities of water.

High-value crops such as lettuce, potatoes, and onions are well adapted to the area.

WATERSHED PROBLEMS AND NEEDS

Floodwater from the draws cause damage to highly developed irrigated cropland, irrigation wells, county roads, State Highway 41, the Atchison, Topeka, and Santa Fe Railroad spur, farm equipment, and farm homes. Draws that flow from west to east cause substantial amounts of damage to lands developed for irrigated crop production, farmsteads, fences, highways, and railroads.

Floods are caused by high-intensity, short-duration rainstroms between May and October. Flood history obtained from the local people indicates that substantial damages are received about every two or three years. In 1967 a storm occurred over a portion of the watershed and resulting floodwaters caused damages estimated at $20,000. The 1967 storm is estimated to be of the size that will occur on the average once every ten

years. The 100-year frequency storm would cause an estimated $125,000 damage by flooding about 900 acres of land with an average depth of 2.0 feet.

The estimated average annual flood damage under future conditions without flood prevention measures is $30,400. The estimated average annual flood damage is distributed as follows: Crop and pasture, $22,400; other agricultural, $4,000; and the highway and railroad, $4,000.

In most areas in the Estancia Valley, the groundwater table is on the decline. From 1948 through 1965 the water table declined as much as 20 feet. Continued decline of the water table will, in time, present a problem of water quality.

There is need for flood protection, water-based recreation, groundwater recharge, grazing land management, increase in vegetative groundcover, and better vegetation conditions. Additional studies will be needed to determine the effects of artificial recharge on water quality.

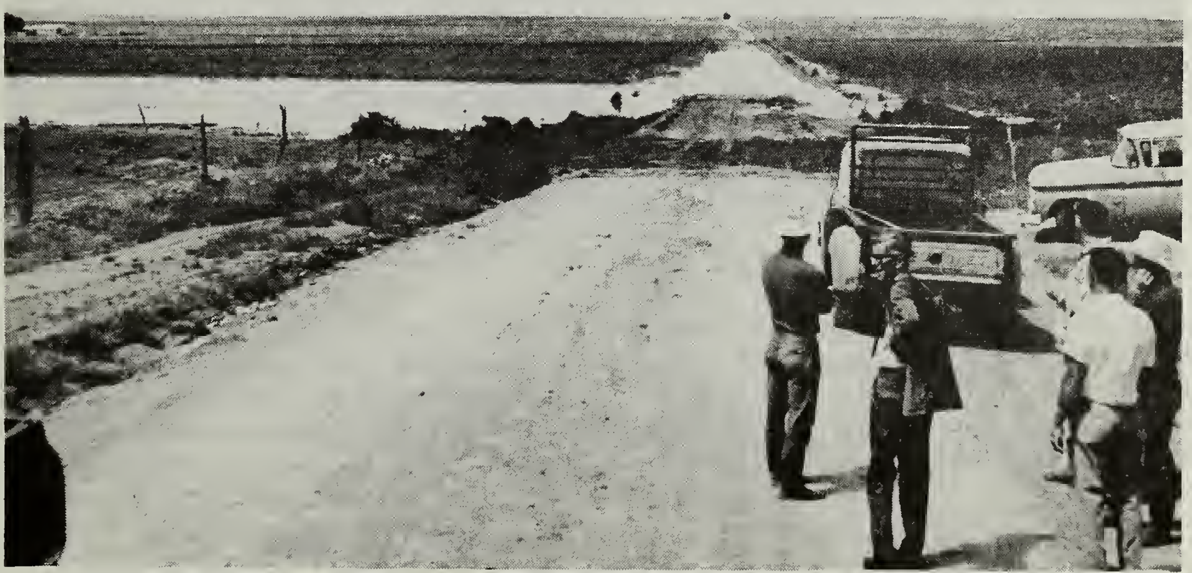


PHOTO AII-7. FLOOD DAMAGE TO ROADS AND CROPS SCS PHOTO 12-P573-5

PHYSICAL POTENTIAL FOR MEETING THE NEEDS

The topography, soils, and foundation conditions at the potential structure site locations do not lend themselves to large permanent water-storage pools. Full time facilities to meet water-based recreation needs cannot be provided by Public Law 566 projects here. Incidental recreational benefits as the flood pools recede are a possibility.

Land treatment measures can be instigated, which will tend to increase cover, decrease runoff and sediment production, and aid in recharging groundwater aquifers. The average annual rainfall, soils, topography, and climate in this area make it possible to attain a high degree of sediment control with land treatment. However, due to the high-intensity rainfall and subsequent high runoff, land treatment alone will not control floodwater.

In addition to the land treatment program, a flood protection project could be installed to control floodwater. Potential floodwater retarding structure sites have been tentatively located. The topography does not lend itself well to building high retarding structures, but the structures can be built long enough so the necessary storage can be obtained.

Available geologic information indicates floodwater retarding structures can be installed without exceptionally high structure cost on valley fill material of clay, sand, and gravel of Pliocene to Recent age. Abutment materials at all structures are erodable. Good material for construction of the earthfills is available. Prevailing materials at potential structure sites are ML-CL and CL.

Permeability at the potential structure sites and down the channels below the sites indicates the possibility of disposal of floodwater by recharging the groundwater aquifer instead of providing stable channels to the salt lakes. It is assumed from information available that this is the most logical and economical way to take care of the principal spillway flow from the potential retarding structures.

LOCAL INTEREST IN PROJECT DEVELOPMENT

Since the flood of 1967, the interest of local people has increased. The local people are aware of the flood hazard and are interested in trying to eliminate the problems. It is recommended that the people form a legal sponsoring organization to guide their search for the best programs available to alleviate their problems.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Protection from critical erosion on 1,500 acres. These small, scattered areas are generally located on steep, poorly vegetated, unstable soils, and in areas of heavy use near farmstead and along roads and trails. Land subject to critical erosion can benefit from small gully plugs, net wire fences, contour furrows, and diversions designed to stabilize the soils so grass seeding will result in protective stands of vegetation.
2. Good range management on 13,000 acres of grassland. Grazing management is essential to all rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through use of additional fences and livestock watering facilities.
3. Brush control on 100 acres of chaparral growing in the upper elevations of the watershed.
4. Pinyon-juniper control on 6,000 acres of woodlands growing on soils and slope conditions adaptable to control.
5. Ponderosa pine management on 10,000 acres. Treatment includes timber stand improvement, establishment, and reinforcement.
6. Improved irrigation systems on 4,000 acres of irrigated land.
7. Dry cropland treatment on 480 acres.
8. Revegetation of 14,000 acres of poorly vegetated, formerly cropped fields. Many fields reseeded under the Conservation Reserve Program failed to respond with stands of desirable grasses adequate to provide protection to the land from wind and water erosion. This formerly cropped land poses a threat to the effectiveness of structural measures that may be installed.
9. Develop ponds for water-based recreation.

Structural Measures

The one potential structural measure is a floodwater retarding structure on Torreon Draw and Arroyo del Cuervo. The principal spillway discharge from this structure could be spread on the rangeland until absorbed thereby serving as groundwater recharge. This can be done at very little cost and is the most economical and logical method of disposing of the principal spillway flow. However, in the event diversion works are needed for spreading water to accomplish the desired recharge, a water right to appropriate and use surface water will be required. The potential structure is single-purpose flood prevention with incidental agricultural water management benefits from the groundwater recharge.

The potential structure is classed as "c" high-hazard site and a concrete chute emergency spillway is assumed necessary (see Tables AII-46 and AII-47, page AII-68, for structural details, and Structure Location and Land Treatment Map, Tajique Watershed, facing page AII-70).

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Potential structures were located on U. S. Geological Survey 15 minute quadrangle sheets. A stage storage curve was developed for each potential floodwater retarding structure to obtain an estimated height of structure.

A centerline profile was taken from the quadrangle sheet by interpolation between contour lines (20-foot contours). The required storage is based on the estimated 100-year sediment yield and the runoff produced by the 100-year frequency storm routed through the structure. Using the above information, an estimate was made of the cubic yards of earthfill needed.

Cost estimates on the potential floodwater retarding structure were based on a cost per cubic yard of earthfill as determined by the lowest five bids on the latest bid for structural measures. Cost for the concrete chute emergency spillway was based on estimates made for similar dam heights in watershed planning. A 20 percent contingency figure was added to the construction cost estimates to offset unforeseen costs of the structural measures.

Other costs were estimated by using cost data from other watersheds with similar conditions.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

With the project installed, the estimated average annual flood damage would be $8,700, or a reduction in average annual damage of approximately 71 percent. Average annual damage reduction benefits from the installation of structural measures are estimated to be $21,700 (see Table AII-49, page AII-69).

Other benefits that would result from the structural measures found feasible in the watershed include the following average annual estimates: Groundwater recharge, $35,900; redevelopment, $21,300; and secondary, $5,500.

Total average annual benefits to the structural measures are estimated to be $84,400 (see Table AII-51, page AII-70). The average annual cost of structural measures is estimated to be $83,800 (see Table AII-50, page AII-70). The benefit-cost ratio is 1:1 (see Table AII-51).

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant onsite problems of critical flood and sediment source areas.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. Quality of runoff water will be improved. The systems will contribute to the improvement, development, and preservation of all watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $74,500. The average annual returns are estimated to be $208,000.

ALTERNATE OR ADDITIONAL POSSIBILITIES

There are many other potential structure site locations within this watershed. Such locations exist on the draws on which the structure site has been located.

There are other methods of handling the principal spillway discharge from the structures: (1) concrete-lined channel to deliver the flow below the railroad and highway. This alternative was investigated and it appeared to be the most expensive method of disposal. (2) artificial recharge wells might be a possibility. This was investigated to obtain a rough cost estimate and would be possible if necessary. A thorough investigation of the water treatment necessary would need to be made since the injected water would have to meet State Health Department requirements.

TABLE AII-46. STRUCTURE DATA, TAJIQUE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classification
1	111.5	42	689,000	R/C conduit	12	R/C chute	1	1,000	c

TABLE AII-47. RESERVOIR STORAGE CAPACITY, TAJIQUE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
1	111.5	810	11,600	12,410	

TABLE AII-48. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, TAJIQUE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measure	Installation Cost				Total Installation cost
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	
1	$1,107,600	$132,900	$ 125,000	$500	$1,366,000

1/ Price base 1969

TABLE AII-49. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, TAJIQUE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated Average Annual Damage		Damage reduction benefits
	Without project	With project	
Crop and pasture	$22,400	$6,700	$15,700
Other agricultural	4,000	1,000	3,000
Highway and railroad	4,000	1,000	3,000
TOTAL	$30,400	$8,700	$21,700

1/ Based on adjusted normalized prices

TABLE AII-50. ANNUAL COST, TAJIQUE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

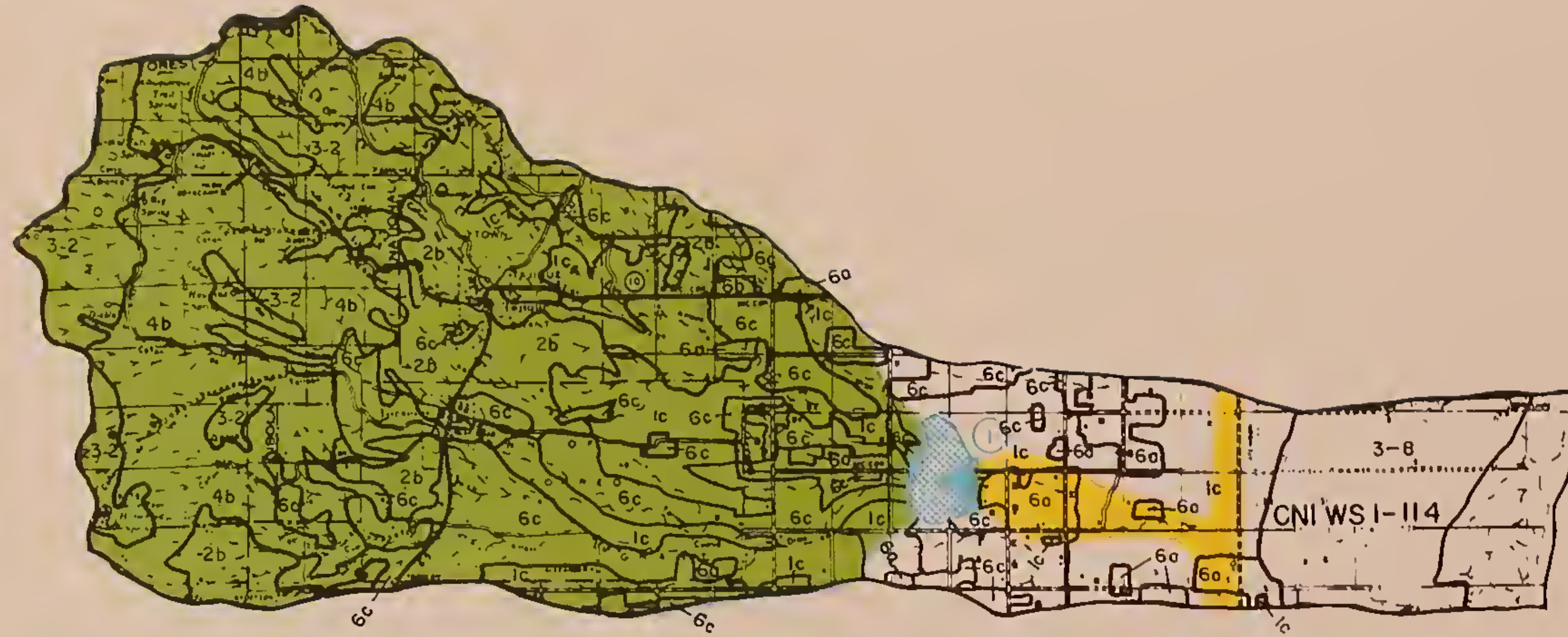
Evaluation Unit	Amortization of installation cost 1/	2/ Operation and Maintenance cost	Total
All structural measures	$73,800	$10,000	$83,800

1/ 1969 costs amortized at 5-3/8 percent interest for 100 years.
2/ Adjusted normalized prices

TABLE AII-51. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, TAJIQUE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average Annual Benefits 1/					Aver. Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	Ground-water recharge	Redevel-opment	Secon-dary	Total		
All structural measures	$21,700	$35,900	$21,300	$5,500	$84,400	$83,800	1.0:1

1/ Adjusted normalized prices
2/ From Table AII-50



LEGEND

Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Irrigation Well	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	22
Federal Highway Number	66
Site Number	2
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Good Range Management	1c
Pinyon-Juniper Management	2b
Chaparral Control and Management	3-2
Fourwing Saltbush Management	3-8
Ponderosa Pine Management	4b
Irrigated Land Management	6a
Dry Land Management	6b
Abandoned Cropland Management	6c
Miscellaneous Land	7

N

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

TAJIQUE WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

1 0 1 2 3 4 5 MILES

SCALE 1:190,000

4-R-34716

USDA-SCS-FORT WORTH TEX 1975

BUFFALO SPRINGS WATERSHED
(CNI 1-119)
TORRANCE COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located in Torrance County in central New Mexico. It drains part of the east side of the Manzano Mountains, and the drainage pattern is in an easterly direction. The north boundary of the watershed is just north of Moriarty and extends to the west into the Manzano Mountains, which form the western boundary of the watershed. The south boundary of the watershed is two miles south of Estancia and the east boundary extends parallel with and about four and one-half miles east of State Highway 41.

The watershed is about 21 miles from north to south, by about 20 miles east to west. The total area of the watershed is 238,000 acres, or 372 square miles, of which 100,000 acres are grassland; 15,000 acres are brushland; 50,000 acres are woodland; 23,000 acres are timberland; and 50,000 acres are farmland. There are 13,500 acres of the farmland irrigated.

The ownership of the watershed is as follows: 8,400 acres administered by the federal government; 216,600 acres of private land; and 13,000 acres of land administered by the state.

Land administered by the federal government is under two separate agencies. The Bureau of Land Management administers 1,400 acres. About 7,000 acres is National Forest land administered by the Forest Service through the Cibola National Forest, Mountainair and Sandia Ranger Districts. The area consists of approximately 1,200 acres of commercial timber; 5,600 acres of non-commercial timber; and 200 acres of grassland.

The project work inventory lists needs for land treatment, vegetative manipulation, and timber stand improvement on the National Forest, all of which should be included in the work plan for this watershed.

The towns of Moriarty and Estancia are located within the watershed. Moriarty is located about 30 miles east of Albuquerque on U. S. Highway 66. Estancia is located 16 miles south of Moriarty. State Highway 41 runs north and south through the watershed and intersects U. S. Highway 60 about 11 miles south of Estancia.

There is a spur line from the Atchison, Topeka, and Santa Fe Railroad, which extends south to Willard where it intersects the main line. Several county roads traverse the area and make all parts of the watershed easily accessible.

PHOTO AII-8. IRRIGATED LAND DAMAGE. NOTE HIGH WATER MARK ON FENCE. SCS PHOTO 12-P514-15

Mean sea level elevations range from about 10,098 feet in the Manzano Mountains to 6,100 feet in the valley. Topography in the watershed ranges from steep, rough mountains to rolling plains and is essentially flat on the valley floor. The watershed is included in the Basin and Range Physiographic Province.

Climate in the valley is favorable to agriculture. The average annual temperature at Estancia is 50°F with a high of about 102°F and a low of about -33°F. Average annual precipitation is about 9.6 inches at Estancia. The average frost-free period is about 138 days, from May 17 to October 13. High value crops such as lettuce, potatoes, and onions are well adapted to the area.

Soils in the mountains and foothills are developing on gently sloping to very steep slopes in limestone, sandstone, and shale materials. Depths range from shallow to deep. Wilcoxson, Supervisor, Pino, and Turkey Springs soil series are representative. Soils below the foothills on valley-fill slopes and piedmont fans are developing on nearly level to strongly sloping topography in mixed alluvial deposits. They are moderately deep to deep and are represented by Witt, Harvey, and Manzano soil series. Soils in the vicinity of McIntosh and Estancia are developing on level to gently sloping topography in terrace lake sediments and wind-deposited soil materials. They are moderately deep and are represented by Willard, Ildefonso, and Karde soil series.

There are two major land resource areas included in the watershed: (1) Arizona and New Mexico Mountains, and (2) Pecos-Canadian Plains and Valleys. Much of the latter is adapted to irrigation crop production.

There are no perennial surface water streams; however, groundwater is fairly accessible. It is necessary to rely upon groundwater for any developments entailing large quantities of water.

Draws that flow from west to east cause substantial amounts of damage to land developed for irrigated crop production, farmsteads, fences, highways, railroads, and residential and commercial property in Estancia. Floods are caused by high-intensity, short-duration rainstorms occurring for the most part from May through October.

WATERSHED PROBLEMS AND NEEDS

Floodwaters from the draws cause damage to highly developed irrigated cropland; irrigation wells; county roads; State Highway 41; the Atchison, Topeka, and Santa Fe Railroad spur; farm equipment, farm homes, and residences and businesses in the town of Estancia.

Flood history obtained from the local people indicates that substantial damages are received about every two or three years.

PHOTO AII-9. MAIN STREET OF ESTANCIA UNDER FLOODWATER FROM AUGUST 1967 FLOOD FROM MILBOURNE AND COMPTON DRAWS.

SCS PHOTO 12-P514-12

Investigation of flood damage in the watershed was made. The most recent flood resulting in major damage occurred in 1967. Other floods caused major damage in the watershed in 1927, 1935, 1942, 1952, and 1904.

In 1967 a storm occurred over a portion of the watershed and resulting floodwaters caused damages estimated at $75,000. The 1967 storm is estimated to be of the size that will occur on the average once every ten years. The 100-year frequency storm would cause an estimated $450,000 damage, flooding about 1,200 acres of land with depths up to 1.0 foot.

The estimated average annual flood damage under future conditions without flood prevention measures is $105,500. Average annual damage to agricultural property amounts to $52,200; and to non-agricultural property including highway, railroad, and urban property in Estancia accounts for the remaining $53,300.

In most areas the Estancia Valley groundwater table is on the decline. From 1948 through 1965 the water table dropped as much as 40 feet.

There is need for flood protection, water-based recreation, groundwater recharge, irrigation water management, increased vegetative cover, and better vegetation condition. Additional studies will be needed to determine the effects of artificial recharge on groundwater quality.

LOCAL INTEREST IN PROJECT DEVELOPMENT

Since the flood of 1967 the interest of the local people has increased. Residents of the town of Estancia are aware of the flood hazard to their community and are interested in trying to eliminate the problem. It is recommended that the people form a legal sponsoring organization and submit their problems to the New Mexico State Engineer and others for consideration for technical and monetary assistance.

PHYSICAL POTENTIAL FOR MEETING THE NEEDS

Average annual precipitation is about 18 inches at Tajique and about 9.6 inches at Estancia. Average annual lake evaporation is about 55 inches. The topography, soils, and foundation conditions at the potential structure site locations do not lend themselves to large permanent water storage pools. Full time facilities to meet water-based recreation needs cannot be provided by Public Law 566 projects here. These needs will have to be met in adjoining subbasins. Incidental recreational benefits as the flood pools recede are a possibility.

The average annual rainfall, soils, topography, and climate in this area make it possible to attain a high degree of sediment control with land treatment. Due to the high-intensity rainstorms and subsequent high runoff, land treatment alone will not control floodwater.

In addition to a land treatment program, a flood protection project is needed. The flood protection project would consist of floodwater retarding structures and outlet channels to be installed so as to enhance groundwater recharge.

Potential floodwater retarding structures have been tentatively located. The topography does not lend itself well to retarding structures; however, long structures can be constructed.

Available geological information indicates floodwater retarding structures can be installed without exceptionally high structure cost on valley fill material of sand, gravel, and clay, which is Pliocene to Recent in age. Abutments at all structures are erodible. Good material for construction of the earthfills is available. Prevailing materials at potential structure sites are ML-CL and CL.

Permeability at the potential structure sites and down the channels below the sites makes possible the disposal of floodwater by recharging the groundwater aquifer instead of providing stable channels to the salt lakes. Partial cutoff in foundation will control velocity of subsurface flow to a safe level without excessive cost. It is assumed from available information that this is the most logical way to take care of the principal spillway discharge from the potential retarding structures.

Gross erosion rates range from 0.26 to 0.38 acre-feet/square mile/year and yield of sediment to reservoirs is approximately 0.1 acre-feet/square mile/year.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Protection from critical erosion on 1,000 acres. These areas are generally on steep, poorly vegetated, unstable soils, and in areas of heavy use near farmsteads and urban areas. Land subject to critical erosion can benefit from small gully plugs, net wire fences, contour furrows, and diversions designed to stabilize the soils in order for grass seeding to produce protective stands of vegetation.
2. Good range management on 21,000 acres of grassland. Grazing management is essential on all rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through use of additional fences and livestock watering facilities.

3. Pinyon-juniper control on 25,000 acres.
4. Chaparral control on about 20 acres.
5. Timberland improvement - establishment or reinforcement on 11,600 acres of ponderosa pine forest land.
6. Improved irrigation systems on 10,000 acres of irrigated land.
7. Dry cropland treatment on 640 acres.
8. Revegetation of 32,000 acres of poorly vegetated, formerly cropped fields. Many fields reseeded under the Conservation Reserve Program failed to respond with stands of desirable grasses adequate to protect the land from erosion. This formerly cropped land poses a serious threat to the effectiveness of structures that may be installed.

Structural Measures

Potential structural measures proposed are floodwater retarding structures on Estancia Draw just west of Estancia, Melbourne, and on Chincante Draws, Compton Draw, and Cienega Draw. The principal spillway discharges from these structures could be spread on the rangeland until absorbed thereby enhancing groundwater recharge. This is the most economical and logical way of disposing of the principal spillway flow. However, in the event diversion works are needed for spreading water to accomplish the desired recharge, a water right to appropriate and use surface water will be required. The potential structures would be single-purpose flood prevention measures with incidental agricultural water management benefits resulting from the groundwater recharge. The potential structures are all classed as "c" high-hazard sites and concrete emergency spillways are assumed necessary. (See Tables AII-52 and AII-53, page AII-79, for structural details and Structure Location and Land Treatment Map, Buffalo Springs Watershed, facing page AII-82, for structure location).

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Potential structures were located on U. S. Geological Survey 15 minute quadrangle sheets. A stage storage curve was developed for each potential floodwater retarding structure to obtain an estimated height of structure. A centerline profile was taken from the quadrangle sheet by interpolation between contour lines (20-foot contours). The required storage is based on the estimated 100-year sediment yield and the runoff produced by the 100-year frequency storm routed through the structure. With this information, an estimated earthfill in cubic yards was made.

Cost estimates on the potential floodwater retarding structures were based on a cost per cubic yard of earthfill as determined by the lowest five bids on the latest projects for which bids were received. Costs for concrete chute emergency spillways were based on estimates made for similar planned Public Law 566 projects. A 20 percent contingency figure was added to the construction cost estimates in order to offset

unforeseen costs of the structural measures. Other costs were estimated by using cost data from planned Public Law 566 watersheds having similar conditions.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

The installation of the structural measures would reduce flood damages by an estimated 87 percent and give average annual benefits of $91,800 (see Table AII-55, page AII-81). Remaining average annual damages after project installation would amount to about $13,700.

Installation of the project would provide secondary benefits in the watershed and general trade area. These benefits would accrue as increased net income to both producers and processors of agricultural products and services. The estimated average annual secondary benefits that would accrue with the installation of the project are $13,700.

Redevelopment benefits resulting from the installation and maintenance of project works of improvement are estimated to be $46,300 when averaged annually over the project life of 100 years. These benefits would result from the employment of local labor now unemployed or not employed full time. These benefits would accrue to the watershed community during construction of the project and by the employment of local labor necessary to operate and maintain project works of improvement for several years.

Groundwater recharge resulting from flood prevention structural measures would afford some increase in beneficial use of flood runoff. The estimated average annual benefits from groundwater recharge are $42,700.

Average annual benefits accruing to structural works of improvement are estimated to be $195,000. The estimated average annual costs for the structural works are $174,600. The benefit-cost ratio is 1.1:1 (see Table AII-57, page AII-82).

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant onsite problems of critical flood and sediment source areas. Total average annual costs for the land treatment systems are estimated to be $165,000. The average annual returns are estimated to be $475,000.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. Quality of runoff water will be improved. The systems will contribute to the improvement, development, and preservation of all watershed resources and their optimum utilization.

ALTERNATIVE OR ADDITIONAL POSSIBILITIES

There are other potential structure site locations within this watershed. Such locations exist on the draws on which structures have been located. There is a possibility structures could be justified on some of the other draws also.

There are other methods of handling the principal spillway discharge from the structures: (1) concrete-lined channel to deliver the flow below the railroad and highway. This alternative was investigated and it appeared to be the most expensive method of disposal. (2) artificial recharge wells where investigated to obtain a rough cost estimate and proved physically possible. A thorough investigation of the water treatment necessary would need to be made since injected water would have to meet State Health Department requirements.

TABLE AII-52. STRUCTURE DATA, BUFFALO SPRINGS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway		Emergency Spillway		Max. surface area emer. spill. level (Ac)	Struc. Classification
				Type	Release rate (csm)	Type	percent chance of use		
1	12.0	19	67,000	R/C conduit	8	concrete	1	240	c
2	55.7	48	818,000	"	8	"	1	540	"
3	20.8	35	849,000	"	8	"	1	170	"
4	11.8	26	30,000	"	8	"	1	100	"

TABLE AII-53. RESERVOIR STORAGE CAPACITY, BUFFALO SPRINGS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
1	12.0	135	1,300	1,435	0.11
2	55.7	515	5,900	6,415	0.09
3	20.8	200	2,200	2,400	0.10
4	11.8	130	1,250	1,380	0.11

TABLE AII-54. DISTRIBUTION OF STRUCTURAL COST OF POTENTIAL DEVELOPMENT, BUFFALO SPRINGS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural measures	Installation Cost				Total Installation cost
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	
Site 1 (Estancia)	$ 191,600	$ 40,300	$ 7,500	$ 300	$ 239,700
Site 2 (Milbourne)	1,072,700	128,700	25,000	500	1,226,900
Site 3 (Compton Draw)	1,129,200	135,500	10,000	500	1,275,200
Site 4 (Cienega Draw)	138,600	29,100	25,000	300	193,000
TOTAL	$2,532,100	$333,600	$67,500	$1,600	$2,934,800

1/ Price base 1969

TABLE AII-55. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, BUFFALO SPRINGS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated Average Annual Damage		Damage
	Without Project	With Project	Reduction Benefits
Crop and pasture	$46,200	$11,500	$34,700
Other agricultural	6,000	1,000	5,000
Subtotal, agricultural	$52,200	$12,500	$39,700
Residential	$31,600	$ 600	$31,000
Commercial	19,200	400	18,800
Highway-railroad	2,500	200	2,300
Subtotal, non-agri.	$53,300	$ 1,200	$52,100
TOTAL	$105,500	$13,700	$91,800

1/ Based on adjusted normalized prices

TABLE AII-56. ANNUAL COST, BUFFALO SPRINGS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

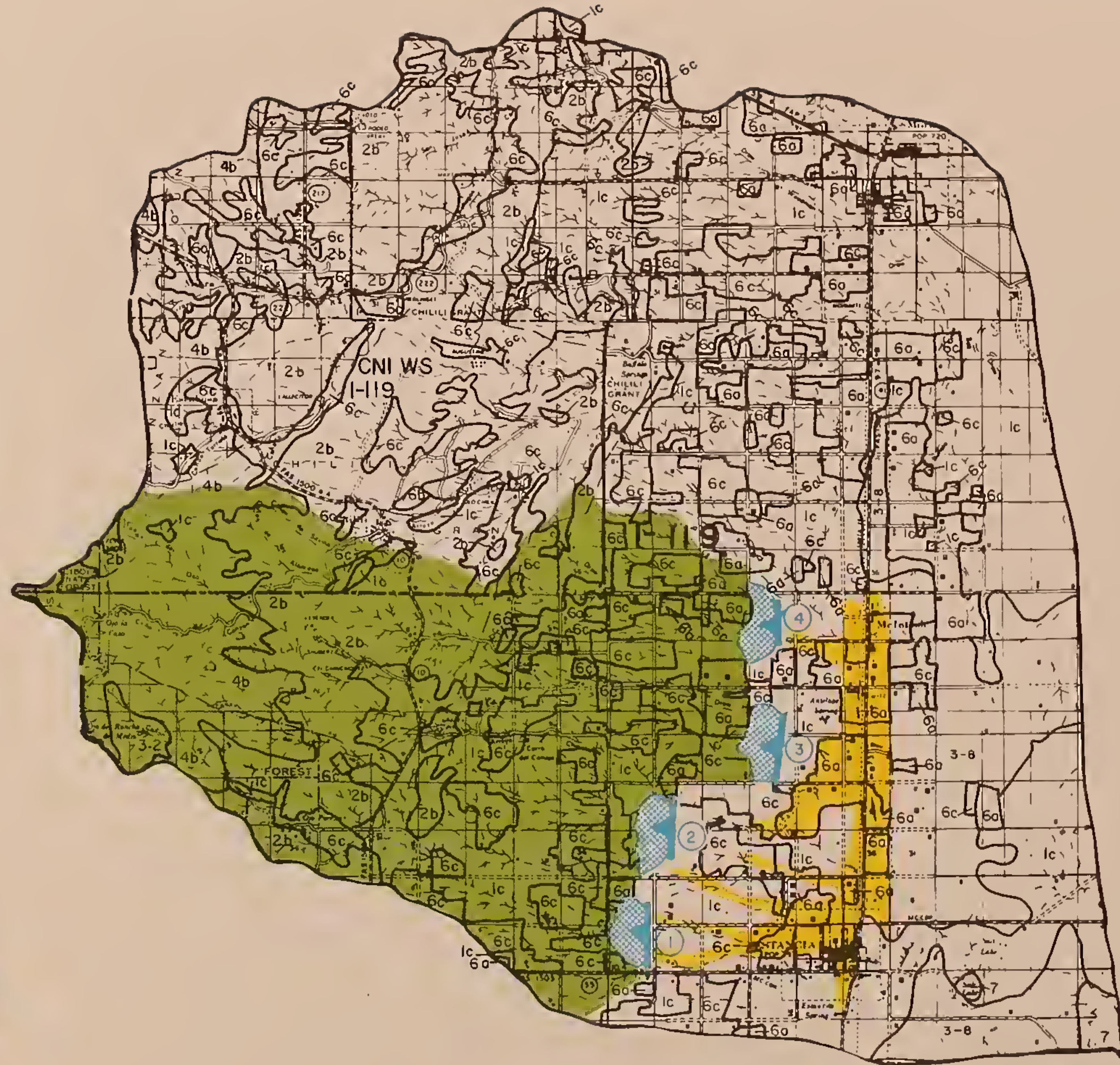
Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
All structural measures	$158,600	$16,000	$174,600

1/ 1969 cost amortized at 5-3/8 percent interest for 100 years.
2/ Adjusted normalized prices

TABLE AII-57. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, BUFFALO SPRINGS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Evaluation Unit	Average Annual Benefits 1/					Average Annual Cost 2/	Benefit-Cost Ratio
	Reduction	Groundwater recharge	Redevelopment	Secondary	Total		
All structures	$91,800	$42,700	$46,800	$13,700	$195,000	$174,600	1.1:1

1/ Adjusted normalized prices
2/ From Table AII-56, page AII-81



LEGEND

Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Irrigation Well	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	22
Federal Highway Number	66
Site Number	2
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Good Range Management	1c
Pinyon-Juniper Management	2b
Chaparral Control and Management	3-2
Fourwing Saltbush Management	3-8
Ponderosa Pine Management	4b
Irrigated Land Management	6a
Dry Land Management	6b
Abandoned Cropland Management	6c
Miscellaneous Land	7

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

BUFFALO SPRINGS WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO

JANUARY 1971

1 0 1 2 3 4 5 MILES

SCALE 1:190,000

4-R-34717

USDA-SCS-FORT WORTH, TEX. 1971

HYER DRAW WATERSHED
(CNI 1-122)
TORRANCE, SANTA FE, AND
BERNALILLO COUNTIES, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located in Torrance, Santa Fe, and Bernalillo Counties in central New Mexico. The draws in the watershed drain the east side of the San Pedro Mountains in an easterly direction and to the south from the Galisteo Divide. The watershed is fan shaped with the fan sides coming together about five miles east of Moriarty. The east boundary extends north to the Galisteo Divide, which forms the northern boundary of the watershed. The west boundary is formed by the San Pedro Mountains. The confluence of the drainages in this watershed is about one and one-half miles east of Moriarty.

The watershed is about 16 miles wide, north to south; about 18 miles long, east to west. The total area of the watershed is 198,400 acres or 310 square miles, of which 125,900 acres are grassland; 500 acres are brushland; 19,000 acres are woodland; 4,000 acres are timberland; and 49,000 acres are farmland. There are 11,000 acres of irrigated farmland.

The ownership of the watershed is as follows: 5,300 acres administered by the federal government; 159,100 acres of private land; and 34,000 acres of land administered by the state.

Land administered by the federal government is under two separate agencies: the Forest Service (3,400 acres) and the Bureau of Land Management (1,900 acres). Of the 3,400 acres of the Cibola National Forest, which includes Sandia Ranger District, approximately 400 acres are classified as commercial and 2,600 acres as non-commercial forest.

The villages of Stanley and Edgewood are within the watershed. The town of Moriarty, which is about 30 miles east of Albuquerque on U. S. Highway 66, is located about one mile south of the watershed boundary at the intersection of U. S. Highway 66 and State Highway 41, which runs north and south through the watershed intersecting U. S. Highway 60 about 26 miles south of Moriarty.

There is a spur line from the Atchison, Topeka, and Santa Fe Railroad, which extends to Moriarty. There are several state and county roads that make all portions of the watershed easily accessible.

Mean sea level elevations range from about 8,240 feet in the San Pedro Mountains to 6,200 feet in the valley. Topography in the watershed ranges from steep, rough mountains to rolling plains and is nearly level on the valley floor. It is included in the Basin and Range Physiographic Province.

Climate in the valley is mild and favorable to agriculture. The average annual temperature is about 50°F with a high of about 102°F. Average annual precipitation is about 12 inches at McIntosh located about 6 miles south of Moriarty. The average frost-free period at McIntosh is about 149 days from May 17 to October 13.

Soils in the higher elevations are shallow to deep and moderately permeable, developing on steep to very steep slopes in watershed granite, gneiss, schist, and mixed alluvium. Soil series representative of the area are Chimayo, Mirabal, Loma, and Hubert. Sixty percent of the watershed's soils are deep and moderately permeable, developing on broad, nearly level, to strongly sloping uplands in ancient mixed alluvium. Witt, Harvey, and Clovis soils are representative. The northeastern part of the watershed has shallow to moderately deep, loamy soils developing on gently sloping to moderately steep slopes in mixed alluvium containing caliche horizons. Dean, Harvey, and Tapia are soil series representative of the area.

There are two major land resource areas included in the watershed: (1) Arizona and New Mexico Mountains, and (2) Pecos-Canadian Plains and Valleys. The latter is very adaptable to irrigated crop production.

There are no perennial surface water streams. Any developments requiring water must depend on use of groundwater, which is fairly accessible.

Floods in draws that flow from west to east cause substantial amounts of damage to land developed for irrigated crop production, farmsteads, fences, and highways. Floods in these draws are caused by high-intensity, short-duration rainstorms between May and October. High-value crops such as lettuce, potatoes, and onions are well adapted to the area.

WATERSHED PROBLEMS AND NEEDS

Floodwater from draws cause damage to highly developed irrigated cropland; irrigation wells; county roads; State Highways 41, 344, and 472; farm equipment; and farm homes.

Floods in these draws are caused by high-intensity, short-duration summer thunderstorms. Flood history obtained from the local people indicates that substantial damages are received about every two or three years. In 1967 a storm occurred over a portion of the watershed and resulting floodwater caused damages estimated at $40,000. This storm is estimated to be of the size that will occur once every five years.

PHOTO AII-10. LETTUCE CROP DESTROYED BY FLOODWATER FROM 1967 STORM. IRRIGATED CROPS ARE DAMAGED FREQUENTLY BY FLOODS. SCS PHOTO 12-PS73-8

The 100-year frequency storm would cause an estimated $300,000 damage in the watershed. Preliminary estimates indicate that about 1,500 acres are flooded to an average depth of about one foot once each three years. On the average, annual damages occur to about 600 acres with flooding up to six inches. It is estimated that the one percent chance storm would flood about 2,800 acres with depths up to three feet.

The estimated average annual crop and pasture damage without flood prevention measures is estimated to be $129,100.

In most areas in the Estancia Valley, the groundwater table is on the decline. From 1948 to 1965 the water table dropped as much as 40 feet.

There is need for flood protection, water-based recreation, groundwater recharge, grazing land management, irrigation water management, increase in vegetative ground cover, and better vegetative condition on grazing land. Additional studies will be needed to determine the effects of artificial recharge on water quality.

Minor areas in the National Forest are in need of timber stand improvement and erosion control.

PHYSICAL POTENTIAL FOR MEETING THE NEEDS

Average annual precipitation is about 18 inches at Tajique and about 12 inches at McIntosh. Average annual lake evaporation is about 60 inches in the valley. The topography, soils, and foundation conditions at the potential structure site locations do not lend themselves to large permanent water storage pools. Except for some incidental recreational benefits realized as the flood pool is drawing down, it is felt water-based recreation needs cannot be satisfied in the subbasin. These needs will have to be met in adjoining subbasins.

The average annual rainfall, soils, topography, and climate in this area make it possible to attain a high degree of sediment control with land treatment. However, due to the high-intensity rainfall and subsequent high runoff, land treatment alone will not control the floodwater.

Along with the land treatment program, a flood protection project is essential. The flood protection project would consist of necessary floodwater retarding structures and outlet channels with installation along the channel to enhance groundwater recharge.

Potential floodwater retarding structures have been tentatively located. The topography does not lend itself very well to retarding structures, but structures that are long enough can be built with the ends turned upstream in order to obtain the necessary storage.

Available geologic information indicates floodwater retarding structures can be installed without exceptionally high structure cost on valley fill material of clay and sand, and materials in the abutments at all structures are erodable. Good material for construction of the earthfills is available. Prevailing materials at potential structure sites are gravel of Pliocene to Recent age, ML-CL, and CL.

Permeability at the potential structure sites and down the channels below the sites makes possible the disposal of floodwater by recharging the groundwater aquifer instead of providing stable channels to the salt lakes. It is assumed from available information that this is the most logical way to take care of the principal spillway flow from the potential retarding structures. A partial cutoff in the foundation will control velocity of subsurface flow to a safe level without excessive cost. Gross erosion rates range from 0.15 to 0.50 acre-feet/square mile/year and yield to reservoir averages about 0.1 acre-feet/square mile/year.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The local people are aware of the flood damage received, but much of the flooding is looked upon as merely a normal annual occurrence that is only detrimental in the event of a large storm. The people interviewed were interested in trying to do something to eliminate, or at least

reduce, floodwater damages. It is recommended that the people form a legal sponsoring organization to obtain guidance and financial support for a project that will alleviate the watershed problems.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Good range management on 62,000 acres of grassland. Grazing management is essential for all rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.
2. Pinyon-juniper control on 2,000 acres.
3. Cholla control on 375 acres.
4. Improved irrigation facilities on 7,000 acres of irrigated land.
5. Dry cropland treatment on 900 acres.
6. Revegetation of 14,000 acres of poorly vegetated, formerly cropped dryland fields. Many fields reseeded under the Conservation Reserve Program failed to respond with stands of desirable grasses adequate to provide protection to the land from wind and water erosion. This formerly cropped land poses the most important threat to the effectiveness of proposed structural measures.

Structural Measures

Potential structural measures include one floodwater retarding structure on Bachelor Draw and one on King-Hyer Draw. Principal spillway discharges from these structures could be spread over the rangeland until absorbed thereby serving as groundwater recharge. This can be done at very little cost and is the most economical and logical method of disposing of the principal spillway flow. However, in the event diversion works are needed for spreading water to accomplish the desired recharge, a water right to appropriate and use surface water will be required. The potential structures would be single-purpose flood prevention measures with incidental agricultural water management benefits from the groundwater recharge. The potential structures are classed as "c" high-hazard sites, and concrete chute emergency spillways are assumed necessary. (See Tables AII-58 and AII-59, page AII-90, for structural details and Structure Location and Land Treatment Map, Hyer Draw Watershed, facing page AII-92, for structure location.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Potential structures were located on U. S. Geological Survey 15 minute quadrangle sheets. A stage storage curve was developed for each potential floodwater retarding structure to obtain an estimated height of structure. A centerline profile was taken off of the quadrangle sheet by interpolation between contour lines (20-foot contours). The required storage is based on the estimated 100-year sediment yield and the runoff produced by the 100-year frequency storm routed through the structure. With this information, an estimated earthfill in cubic yards was made.

Cost estimates on the potential floodwater retarding structures were based on a cost per cubic yard of earthfill as determined by the lowest five bids on the latest Public Law 566 contract. Cost for concrete chute emergency spillway was based on estimates made for similar dam heights and drainage areas in watershed planning. A 20 percent contingency figure was added to the construction cost estimates to offset unforeseen costs of the structural measures.

Other costs were estimated by using cost data from other watersheds with similar conditions.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

With the potential project installed, average annual damages are estimated to be $25,800, a reduction of about 80 percent, which gives average annual damage reduction benefits of $103,300 (Table AII-61, page AII-91). The average annual crop and pasture damage reduction benefits are estimated to be $87,700.

Other average annual benefits that the structural measures would bring about are as follows: Groundwater recharge, $120,900; redevelopment, $61,200; and secondary, $21,300.

Total evaluated average annual benefits amount to $306,700. The average annual cost of the structural measures is $231,300. The benefit-cost ratio is 1.3:1 (Table AII-63, page AII-92).

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant onsite problems of critical flood and sediment source areas.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. Quality of runoff water will be improved. The systems will contribute to the improvement, development, and preservation of all watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $96,000. The average annual returns are estimated to be $181,000.

ALTERNATIVE OR ADDITIONAL POSSIBILITIES

There are other potential structure site locations within this watershed. Such locations exist on the draws on which structures have been located and structures possibly could be justified on some of the other draws on which structures have not been shown in this report.

There are other methods of handling the principal spillway discharge from the structures: (1) concrete-lined channel to deliver the flow below the railroad and highway. This alternative was superficially investigated and it appeared to be the most expensive method of disposal. (2) artificial recharge wells might be a possibility. This was investigated to obtain a rough cost estimate and would be possible if necessary. A thorough investigation of the water treatment would need to be made since the injected water would have to meet State Health Department requirements. This may not be economically possible. If research develops a feasible method of controlling surface evaporation, then surface storage may be feasible.

TABLE AII-58. STRUCTURE DATA, HYER DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (Cu Yd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classification
1	98.4	38	1,100,000	R/C conduit	8	R/C chute	1	410	c
2	144.9	34	1,105,000	"	14	"	1	1,400	"

TABLE AII-59. RESERVOIR STORAGE CAPACITY, HYER DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
1	98.4	800	10,500	11,300	0.08
2	144.9	995	12,500	13,495	0.07

TABLE AII-60. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, HYER DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost: Construction	Installation Cost: Installation services	Installation Cost: Land, easements, & rights-of-way	Installation Cost: Administration of contracts	Total Installation cost
1	$1,444,800	$173,400	$ 75,000	$ 600	$1,693,800
2	1,782,400	213,900	90,000	600	2,086,900
TOTAL	$3,227,200	$387,300	$165,000	$1,200	$3,780,700

1/ Price base 1969

TABLE AII-61. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, HYER DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated Average Annual Damage Without Project	Estimated Average Annual Damage With Project	Damage Reduction Benefits
Site 1 - Bachelor Draw			
Crop and pasture	$44,600	$8,900	$35,700
Other agricultural	5,000	1,000	4,000
Roads and miscellaneous	3,000	600	2,400
Subtotal	$52,600	$10,500	$42,100
Site 2 - King Draw			
Crop and pasture	$ 65,000	$13,000	$52,000
Other agriculture	7,500	1,500	6,000
Roads and miscellaneous	4,000	800	3,200
Subtotal	$ 76,500	$15,300	$61,200
TOTAL	$129,100	$25,800	$103,300

1/ Based on adjusted normalized prices

TABLE AII-62. ANNUAL COST, HYER DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Site 1 - Bachelor Draw	$ 91,500	$10,000	$101,500
Site 2 - King Draw	112,800	17,000	129,800
TOTAL	$204,300	$27,000	$231,300

1/ 1969 cost amortized for 100 years at 5-3/8 percent interest
2/ Adjusted normalized prices

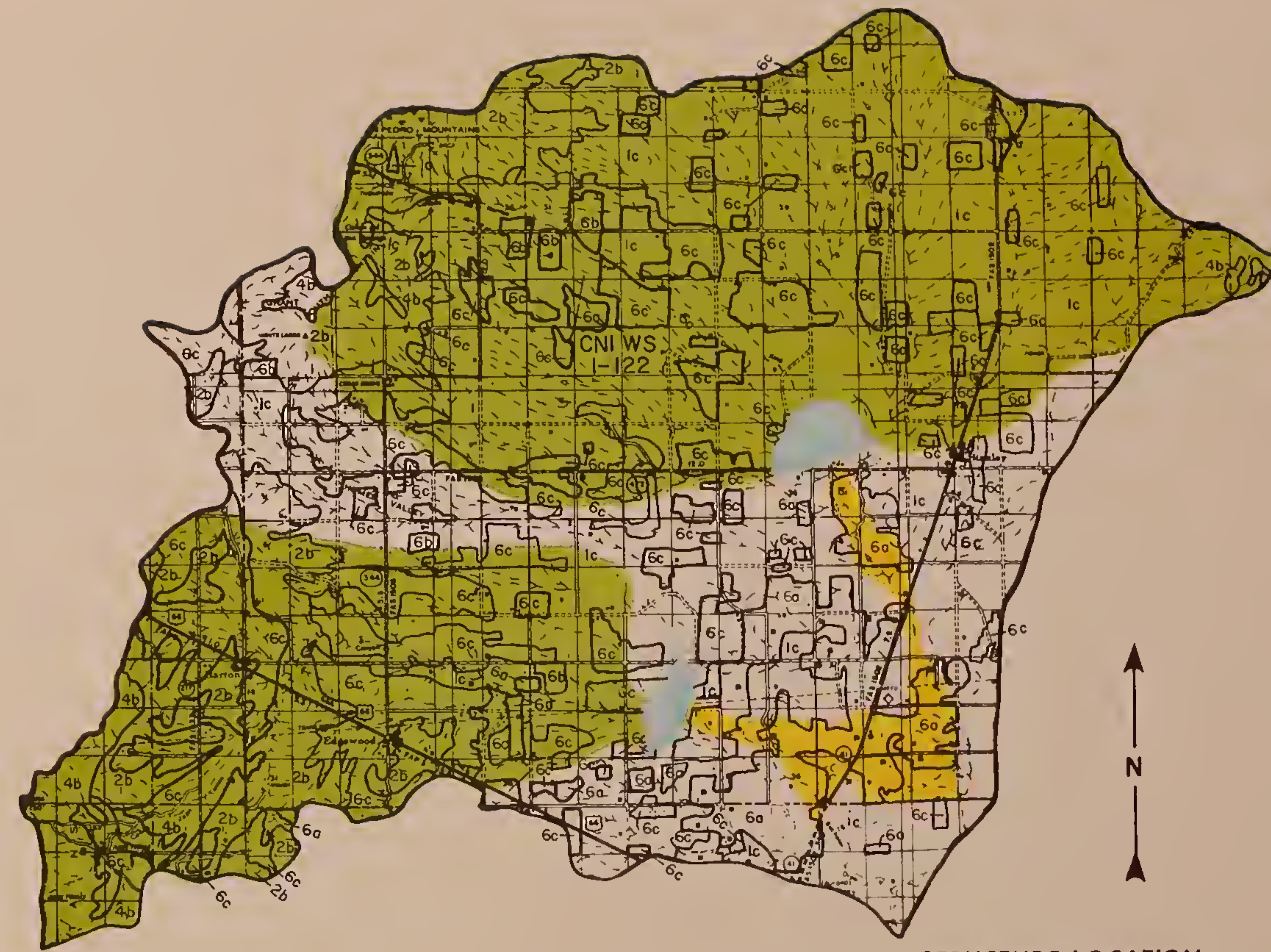
TABLE AII-63. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, HYER DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

	Average Annual Benefits 1/					Average	Benefit-
Evaluation Unit	Damage reduction	Groundwater recharge	Redevelopment	Secondary	Total	Annual cost 2/	Cost Ratio
Site 1 - Bachelor Draw	$ 42,100	$ 59,200	$26,900	$ 9,700	$137,900	101,500	1.4:1
Site 2 - King Draw	61,200	61,700	34,300	11,600	168,800	129,800	1.3:1
TOTAL	$103,300	$120,900	$61,200	$21,300	$306,700	231,300	1.3:1

1/ Adjusted normalized prices
2/ From Table AII-62.

LEGEND

Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Irrigation Well	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	22
Federal Highway Number	66
Site Number	2
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Good Range Management	1c
Pinyon-Juniper Management	2b
Ponderosa Pine Management	4b
Irrigated Land Management	6a
Dry Land Management	6b
Abandoned Cropland Management	6c



STRUCTURE LOCATION AND LAND TREATMENT MAP

HYER DRAW WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

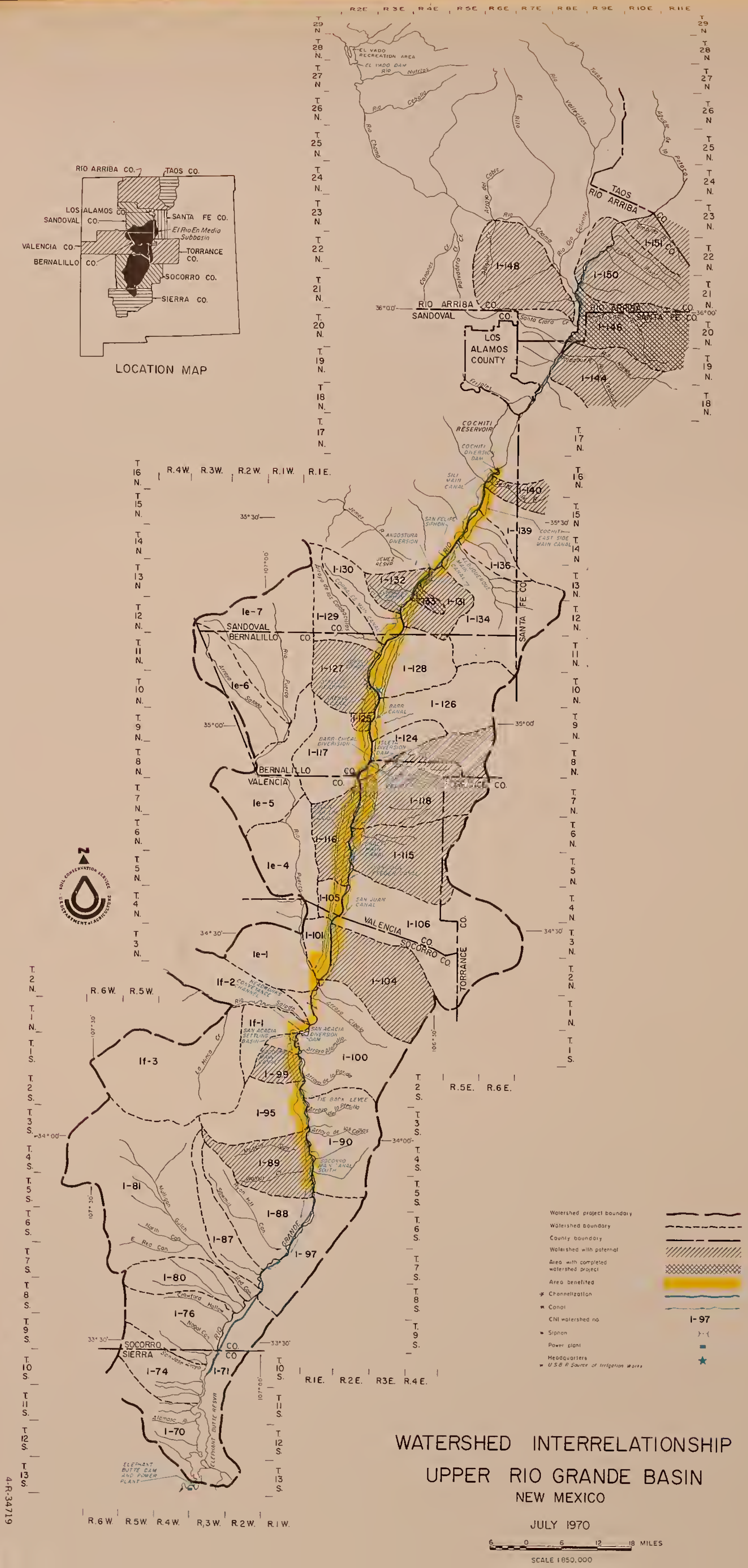
1 0 1 2 3 4 5 MILES
SCALE 1:190,000

4-R-34718

INTERRELATED WATERSHEDS

UPPER RIO GRANDE BASIN

The following six watershed investigation summaries are in the Middle Rio Grande. These watersheds are interrelated because each damage the irrigation system that serves the Middle Rio Grande Conservancy District and causes interruption of irrigation services to district lands. The diversion dams and canal are shown on the Watershed Interrelationship, Upper Rio Grande Basin Map, facing page AII-94.



WATERSHED INTERRELATIONSHIP
UPPER RIO GRANDE BASIN
NEW MEXICO

JULY 1970

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

PAJARITO ARROYOS WATERSHED
(CNI 1-125 AND 1-127)
BERNALILLO COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located on the west side of the Rio Grande and includes portions of the west part of the city of Albuquerque. The north boundary is just north of U. S. Highway 66 and the east boundary, running south along the Rio Grande about ten miles, extends just south of the Isleta Pueblo boundary line. The west boundary is the boundary between Rio Puerco and the Rio Grande. In 1960 a watershed application was submitted for assistance for flood protection in the vicinity of the community of Pajarito. The application covers an area of 51,200 acres, or approximately 80 square miles, in Bernalillo County.

All of the land in the watershed is privately owned. There are about 10,880 acres of irrigated cropland and residential development. All of this land is subject to floodwater damage. Numerous arroyos drain the slopes of the west mesa to the Rio Grande. Since the development of the valley area, none of the arroyos have natural outlet channels to the Rio Grande. The arroyos drain into the Gun Club Canal and drainage ditches.

The Gun Club Irrigation Canal furnishes irrigation water to all of the irrigated land within the watershed. The Gun Club Canal is an extension of the Albuquerque Main Canal, which furnishes irrigation water to land in the Sandia and Corrales Watersheds, which are located north and upstream of the Pajarito Watershed. The Canal furnishes irrigation water to farmland on the west side of the river in the Middle Rio Grande Conservancy District.

Elevations within the watershed range from about 4,900 feet above mean sea level at the Rio Grande to about 6,060 feet at the divide between the Rio Grande and Rio Puerco drainages.

Climatic conditions within the watershed are semiarid with an average annual precipitation of about nine inches. The mean temperature is about 75°F in the summer to about 34°F in the winter.

The land use on this watershed has changed from range to urban-industrial. There are some cattle that are grazed on the watershed; however, for the most part grazing is excluded or limited and the grasslands are receiving better than average management.

The damage area of the watershed is generally from State Highway 45 to the Rio Grande. This damage area consists of irrigated cropland and highly developed sections of residential areas. The watershed is in the

Southern Desertic Basins, Plains and Mountains Land Resource Area and is within the Four-Corners Economic Development Region.

WATERSHED PROBLEMS AND NEEDS

None of the arroyos have natural outlet channels to the river. The arroyos drain into the Gun Club Canal filling it with sediment, overflowing the banks, and causing flooding of the area below the canal, interrupting irrigation services to 5,000 acres of land. Some flooding was reported by the local people to occur every year. A substantial amount of damage to residential areas was reported in 1963, 1965, and twice in 1969. It is estimated that the 1965 and 1969 storms were about the same size with a frequency about the size of a two-year frequency event. It is estimated under future projected conditions that a storm the size of the 1969 storm would cause about $100,000 of flood damages and the 100-year frequency flood would cause an estimated flood damage of $3 million. It is projected that in 25 years the damage area will have one house per acre. There are about 7,300 acres subject to damage from the 100-year frequency flood.

The damages mentioned above are caused by runoff from high-intensity, short duration thunderstorms. The hydrologic cover condition is poor; therefore, the runoff and sediment rates are fairly high. A portion of the damages are due to water conveyed by the canal.

Approximately seven percent of the watershed has critical erosion problems. These are in small scattered areas generally on steep, poorly vegetated, unstable soils and in areas of heavy use near industrial urban areas. Land treatment over the total watershed area is needed in conjunction with a structural measures program to reduce the flooding of residences, crops, irrigated land, irrigation facilities, and highways.

Treatment measures are needed to improve irrigation water management and enhance the productivity of the land. Throughout the main canal system and on the farms there is a need and opportunity for improving the irrigation water application systems.

Cultivated land comprises about ten percent of the watershed; 240 acres need drainage, and 2,160 acres need improved irrigation systems.

To supplement the land treatment measures, floodwater retarding structures and outlet channels would be needed to obtain the necessary protection in the damaged area.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Low precipitation, topography, and high evaporation rates makes it impractical to plan permanent water for any purpose. Irrigation and drainage facilities that are maintained and operated by the Middle Rio

Grande Conservancy District are considered to be adequate. It would be possible to install land treatment measures on the upper portion of the watershed area in order to help alleviate the problems. Due to the low precipitation, topography, soils, and cover, land treatment alone would not meet the desired level of protection.

The topography of the area lends itself well to locating structures on the individual arroyos; however, it is felt that a very high degree of flood protection is needed and possibly the location of structures controlling more than one arroyo would be the most economical method of flood prevention in this area.

Potential structure sites are located in the Santa Fe Group of geologic strata and would present no unusual installation or maintenance problems. However, outlet works for the structures would present a problem as they would need to traverse highly developed residential and expensive irrigated land. Therefore, it is felt the use of existing irrigation facilities would be the most logical method of conveying the water from the principal spillway of the structures to the river.

LOCAL INTEREST IN PROJECT DEVELOPMENT

A watershed application was submitted for assistance under Public Law 566 in 1960. In July 1962 a preliminary investigation report was made that indicated a feasible project could be developed and justified. It was recommended that the sponsors organize a watershed district to handle easements and rights-of-way, operation and maintenance, and other responsibilities to be carried out by the local people. At this time the Albuquerque Flood Control District has agreed to assume these responsibilities and carry out the financial responsibilities of the local organization.

The application as submitted does not cover the whole problem area. It is recommended the application be amended to include the additional area to the north and south as shown on the Structure Location and Land Treatment Map, Pajarito Arroyos Watershed, facing page AII-104.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Good range management on 640 acres of grassland. Grazing management is essential to all areas still used for range. Effective grazing systems include deferred grazing, rotation-deferred grazing, and

better livestock distribution through the use of additional fences and livestock watering facilities.

2. Effective drainage systems on 240 acres of crop, pasture, and hayland.
3. Improved irrigation facilities on 2,160 acres of irrigated land.
4. Erosion control on 3,370 acres of critically eroded land. These areas are generally on steep, poorly vegetated, unstable soils and in areas of heavy use near industrial urban areas. Effective methods that may be used on land subject to critical erosion are small gully plugs, net wire fences, contour furrows, and diversions designed to stabilize the soils so protective stands of vegetation will result from grass seeding.

Structural Measures

Potential structural measures designed for flood protection within this watershed include five floodwater retarding structures and three floodwater diversions. A lined channel would carry the principal spillway discharge from the potential structure site 1 to the Rio Grande. The principal spillway discharge from the other four potential floodwater retarding structures would be carried by lined channel to the Isleta Drain. The capacity of the drain would be increased to handle the flood flows to a point near the Isleta Indian Reservation where a new channel would be constructed directly to the river.

The potential structures would be single-purpose flood control structures. They would control floods on about 55 square miles of a 62 square mile area presently contributing to flood damages. See Structure Location and Land Treatment Map, Pajarito Arroyos Watershed, facing page AII-104, for structure locations, and Tables AII-64 through AII-67, pages AII-101 through AII-103 for structure details.

Throughout the main canal system and on the farms there is an opportunity for improving the irrigation water application systems. Most of the on-farm improvements could be applied on a watershed basis; however, the entire delivery system should be analyzed through the conservancy district. This planning and installation of improvements could best be accomplished by a joint federal agency, New Mexico State Engineer, and local water users effort. For this report no specific items of improvement are identified or evaluated.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Investigation of the watershed was made at a reconnaissance level. A field reconnaissance was made using aerial photos and 1:24,000 U. S. Geological Survey quadrangle sheets. Potential structure sites were checked on site and on the quadrangle sheets. Structure location on the quadrangle sheets was used to estimate structure capacity and the required earth embankment. Items of work would be earth embankment and reinforced concrete chute emergency spillways for five floodwater

retarding structures, earth excavation, and embankment in four floodwater diversions, earthwork for cleaning and enlarging the Isleta Drain and constructing a channel to the river from the drain. Concrete-lined channels are proposed as principal spillway discharge channels from each structure to the drain. Several bridges and/or culverts on highways would be required.

The estimated cost of construction and installation services was made by applying a unit cost to the estimated embankment volume. This unit cost value was taken from curves developed from detailed data prepared for Public Law 566 projects in New Mexico. Other estimated costs are based on preliminary design for quantities from map data and applying current unit cost values to these quantities.

The area where the potential structures would be located is all privately owned. Obtaining land and easements should not present a problem. Land costs will be high and will be a significant part of the cost of the project. Under present conditions no major roads or utility lines would need to be changed or moved.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

The installation of the needed structural measures would provide a high degree of protection to about 7,300 acres of land. Most of this land is expected to be in urban use within 25 years.

The installation of structural measures would control about 89 percent of the drainage area and would reduce present damages by approximately 92 percent. With a fully developed urban area and without flood control measures, the average annual damage is estimated to be $371,000. These damages could be reduced to about $30,000 annually with the installation of project measures. The resulting damage reduction benefits would be $341,000.

Redevelopment and secondary benefits associated with the installation, operation, and maintenance of the project measures are estimated to be about $80,500 on an annual basis. The total project benefits are estimated to be $421,500; and when compared to the $291,000 average annual cost of structural measure, a benefit-cost ratio of 1.4:1 is derived.

The land treatment systems suggested for this watershed are groups of interdependent measures primarily designed to correct the dominant onsite problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $37,900. The average annual returns are estimated to be $108,800.

This project, if installed, would enhance environmental control by reducing sediment yield to the Rio Grande and reducing dust particles in the air.

ALTERNATIVE AND ADDITIONAL POSSIBILITIES

This report includes structural measures that are considered feasible. There are alternate site locations on each of the arroyos. These alternate structure sites should be considered in detail in planning. To eliminate the flood hazard caused by the canal, possibly a study to determine the feasibility of constructing an underground conveyance system is needed. This would have to be done on something broader than a watershed by watershed basis.

TABLE AII-64. STRUCTURE DATA, PAJARITO ARROYOS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (Cu Yd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classification
1	34.2	36	1,360,593	R/C conduit	8	R/C chute	1	255	c
2	9.1	23	349,000	"	8	"	1	180	"
3	5.7	31	487,900	"	8	"	1	120	"
4	2.8	32	191,326	"	8	"	1	40	"
5	3.7	19	237,978	"	8	"	1	65	"

TABLE AII-65. RESERVOIR STORAGE CAPACITY, PAJARITO ARROYOS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
1	34.2	1,117	2,700	3,817	0.32
2	9.1	234	900	1,134	0.26
3	5.7	209	450	659	0.37
4	2.8	166	220	386	0.59
5	3.7	149	290	439	0.40

TABLE AII-66. CHANNEL DATA, PAJARITO ARROYOS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Channel Designation	Length of reach (100 ft)	Watershed area (SqMi)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Est. vol. of fill or excavation (CuYd)
FWD 1a	73	2.35	2,600	300	4.2	4.0	181,200
FWD 1b	93	10.65	5,325	450	4.5	5.0	366,800
FWD 2 (Dike)	75	2.26	2,486	-	5.0	-	18,000 fill
FWD 3	18	5.70	1,463	100	5.0	3.0	37,000
Channel 100	115	-	280	4	4.5	15.0	conc. lined
Channel 200	46	-	93	4	3.0	9.0	conc. lined
Channel 300	32	-	46	3	3.0	6.0	conc. lined
Channel 400	20	-	33	2.5	3.0	5.0	conc. lined
Channel 500	27	-	30	2.5	3.0	5.0	conc. lined
Isleta Drain	366	-	250	15	5.0	3.0	75,000

TABLE AII-67. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, PAJARITO ARROYOS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost				Total
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	Installation cost
Floodwater retarding structures					
Site 1	$ 970,000	$ 323,000	$ 300,000	$1,000	$1,594,000
Site 2	341,000	113,000	190,000	1,000	645,000
Site 3	355,000	153,000	140,000	1,000	649,000
Site 4	160,200	67,000	24,500	500	252,000
Site 5	186,000	80,300	39,500	500	306,000
Floodwater Diversion 1a	163,000	54,000	41,500	500	259,000
1b	330,000	110,000	38,500	500	479,000
2	15,000	6,000	109,000	500	131,000
3	19,000	6,000	1,500	500	27,000
Principal Spillway Outlet Channel					
Channel 100	235,000	94,000	53,500	500	383,000
Channel 200	35,000	16,000	12,500	500	64,000
Channel 300	24,000	12,000	11,500	500	48,000
Channel 400	14,000	6,000	4,500	500	25,000
Channel 500	18,000	7,000	4,500	500	30,000
Isleta Drain	69,700	35,300	41,500	500	147,000
TOTAL	$2,935,000	$1,082,000	$1,013,000	$9,000	$5,039,000

1/ Price base 1969

TABLE AII-68. ANNUAL COST, PAJARITO ARROYOS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Floodwater retarding structures 1, 2, 3, 4, and 5; and all channel improvements	$272,300	$18,700	$291,000

1/ Amortized at 5-3/8 percent interest for 100 years
2/ Adjusted normalized prices

TABLE AII-69. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, PAJARITO ARROYOS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage		Damage Reduction Benefits
	Without Project	With Project	
Flood Damage (urban)	$371,000	$30,000	$341,000

1/ Based on adjusted normalized prices

TABLE AII-70. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, PAJARITO ARROYOS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average Annual Benefits 1/				Aver. Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	Redevelopment	Secondary	Total		
Floodwater retarding structures 1, 2, 3, 4, and 5; and channel improv.	$341,000	$49,600	$30,900	$421,500	$291,000	1.4:1

1/ Adjusted normalized prices
2/ From Table AII-68

LEGEND

- Watershed Boundary
- County Boundary
- Town
- Drainage
- Divided Highway
- Paved Highway
- Gravel Road
- Unimproved Roads
- Bridge
- Railroad
- Pipeline
- Canal
- Dwelling or Farm Unit
- Business & Post Office
- School
- Church
- Cemetery
- Corral
- Windmill
- Spring
- Conservation Needs Inventory Watershed No. — 1-119
- State Highway Number — 22
- Federal Highway Number — 66
- Site Number — 2
- Potential Floodwater Retarding Structure
- Area Controlled
- Area Benefited
- Floodwater Diversion
- Dikes or Levees (Existing)
- Outlet Channel
- Low Water Channel M.R.G.C.D.
- Good Range Management — Ic
- Bottomland and Vegetation Management — 5
- Irrigated Land Management — 6a
- Miscellaneous Land — 7
- Critical Erosion Area — 8

N

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

PAJARITO ARROYOS WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

2 0 2 4 MILES
SCALE 1:126,720

4-R-34710

USDA-SCS-FORT WORTH TEX. 1975

HELL'S CANYON WATERSHED
(CNI 1-118)
VALENCIA AND BERNALILLO COUNTIES,
NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located about ten miles south of Albuquerque and includes parts of Bernalillo and Valencia Counties, New Mexico. The watershed comprises 183,872 acres (287.3 square miles). Land status in the watershed includes 22,855 acres of public land (9,722 acres are administered by the Forest Service; 2,253 acres by the Bureau of Land Management; and 10,880 acres are military reservation); 54,122 acres are privately owned; 103,444 acres are Indian land; and 3,451 acres are state land.

Land use is divided between about 119,000 acres of grassland; 51,000 acres of woodland; 750 acres of bottomland vegetation; and 12,000 acres of irrigated cropland.

The relief pattern is to the west, draining the west slopes of the Manzano Mountains, which form the eastern watershed boundary. The west boundary extends about 12 miles along the Rio Grande. Several small communities are within the watershed. State Highway 47 traverses the watershed from north to south.

Mean sea level elevations range from 4,900 feet at the Rio Grande to almost 10,000 feet in the Manzano Mountains. Topography in the mountain area is steep and rough. The rest of the watershed has a gentle slope westward to the brakes on the east side of the Rio Grande. The bottomlands are nearly level.

Temperatures in the valley range from a high of 104°F to a low of -5°F with an average of 57°F. The average frost-free period is 166 days from May 5 to October 15. Most of the precipitation occurs as rainfall from convective-type summer thunderstorms, usually of high intensity and short duration. Climatic conditions are semi-arid with an average annual precipitation of about 8 inches at Belen to about 25 inches in the mountains.

Arroyos in the watershed originally had channels with outlets into the Rio Grande channel. In recent years, however, the broad flat bottomland along the Rio Grande has been developed into highly productive cropland. As the bottomland was developed, the arroyos were leveled and now terminate and empty into the main irrigation canal. Channels to convey flood flows to the river are non-existent.

The watershed is within the New Mexico and Arizona Plateaus and Mesas and the Arizona and New Mexico Mountains Land Resource Areas. It is included in the Mexican Highland Section of the Basin and Range Physiographic Province. The range condition is fair, but the hydraulic cover condition over most of the area is poor. Erosion rates vary up to 4.0 acre-feet/square mile/year in the "badlands" section of the watershed.

Of the 5,000 acres of National Forest administered land in the watershed, about 1,000 acres are classed as commercial and 4,000 acres as non-commercial forest.

WATERSHED PROBLEMS AND NEEDS

Floodwater and sediment damage roads, residences, irrigation facilities, farm equipment, and irrigated cropland. High-intensity, short-duration thunderstorms falling on rangeland with poor hydrologic cover conditions and steep, rough topography, concentrate the runoff quickly, causing large peak discharges in the arroyos. These conditions make the watershed area susceptible to severe erosion. Approximately two to three percent of the watershed has critical erosion problems.

Floodwater from the arroyos flows directly into the main irrigation canal. The canal fills with sediment that causes the canal to break and inundate the irrigated cropland. About 700 acres of crops and cropland are damaged every year from floods. Damages from interrupted irrigation services occur on an additional 4,000 acres of land.

Where county roads cross arroyos they receive damage from being either washed out or filled with sediment. Damage of this type occurs in the watershed annually.

There are approximately 400 farm homes, small businesses, and rural nonfarm residences subject to flooding. The agricultural area flooded by the one percent chance storm event is estimated to be 9,400 acres. Agricultural damages to crops and pastures amount to about $139,400 annually. Other agricultural damages requiring repairs to irrigation canals, and roads and bridges and releveling land are estimated at about $24,200. Average annual damage to urban development is estimated at $146,000. Indirect damages associated with flooding are estimated to be $31,000 annually. The sum of all of these damages amounts to $340,600 per year.

There is a need for improved land treatment and other flood prevention measures to control the floodwater and sediment discharged from the arroyos. Land treatment on the irrigated cropland is needed to improve water management and lower water tables in some locations.

The entire irrigated area of the watershed is in the Middle Rio Grande Conservancy District. The district operates and maintains the major canals and delivery systems. There is a need for some additional water

PHOTO AII-11. HEAVILY USED RANGE ENCOURAGES SNAKE WEED ENCROACHMENT AND EXPOSURE OF ERODABLE SOILS. SCS PHOTO 12-P1021-4

control structures in the system, and in some areas canal lining would be of value.

Many of the laterals and on-farm ditches need to be lined and have control structures installed. For this investigation report, specific sites for lining and structures have not been identified.

The entire irrigated area needs to be investigated and a reorganization planned in conjunction with the conservancy district irrigation systems.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Due to the low average annual precipitation and high evaporation rate, permanent water storage for any purpose is not considered feasible. However, there are many locations with potential for developing picnic and camping areas, both near the Rio Grande and in the mountains.

There are adequate locations for floodwater retarding structures to control floods originating in the watershed. Field investigations indicate adequate borrow of sand and some clay for construction. Cutoff depths will be less than 20 feet and all excavation will be common. Some scour will occur in unlined outlet channels flowing across silty sands.

Numerous possible structure locations are to be found upstream from the ones located in this report. However, the upstream locations would lessen the control and increase the cost of outlet channels.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The people contacted were aware of the floodwater problem and were interested in finding a solution. The people are conservation minded and most of them participate in the installation and application of needed conservation practices.

At this time there is no legal organization for the installation, operation, and maintenance of a PL-566 project. Local people feel that such an organization could be formed if the flood control measures were economically feasible. The district conservationist and natural resource district should encourage the people to obtain legal organization to sponsor a project.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Good range management on 52,439 acres of grassland. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.
2. Pinyon-juniper control on 2,335 acres of land.
3. Phreatophyte control on 384 acres of land.
4. Effective drainage systems on 1,697 acres of crop, pasture, and hayland.
5. Improved irrigation facilities on 7,575 acres of irrigated land.
6. Management of 100 acres of abandoned cropland.
7. Erosion control on 4,955 acres of critically eroded land. These areas are generally on the steep, poorly vegetated, unstable soils on the breaks just east of the high irrigation canal and in areas of heavy use near farmsteads and urban development. Soils, climatic and topographic conditions team up in the lower elevations of this watershed to make land treatment difficult and expensive but not impossible. Effective methods that may be used to control erosion are small gully plugs, net wire fences, contour furrows, and diversions in an attempt to stabilize the soils so grass seeding will result in protective stands of vegetation.

Needs for timber stand improvement, vegetative manipulation, and erosion control are listed in the National Forest Project Work Inventory and should be given consideration in preparation of the work plan.

Structural Measures

To meet the needs of flood control in the watershed, five potential retarding structures are proposed. Because there are no existing channels to the river, outlet channels would have to be installed with each structure to convey the principal spillway discharges to the river. Based on this investigation, it is felt that the use of irrigation canals and drainage ditches would be the most feasible approach as it would contribute to both flood prevention and agriculture water management. These channels would discharge into existing drains and wasteways to the Rio Grande.

The potential structures would be single-purpose flood control units. Part of the structures would be long embankments to provide maximum protection from the numerous arroyos emptying into the area.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Investigation of the watershed was at a reconnaissance level. U. S. Geological Survey quadrangle maps (1:24,000 scale) and aerial photos of the area were used and supplemented by a field reconnaissance of possible site locations. Data was developed from the quadrangle maps to estimate the capacity of the potential structures and also to determine the estimated volume of fill material needed for an embankment to store the required sediment and floodwater.

The principal item of construction would be earth embankment and concrete for the five floodwater retarding structures. Each will have a reinforced concrete conduit with associated controls for a principal spillway. The outlet channels would have control structures where they drop into the drain or wasteway and structures at canal and road crossings. The estimated construction and installation service cost was determined by applying a unit cost figure to the estimated volume of embankment. This unit cost figure is taken from curves developed from data on PL-566 projects where detailed quantitities and costs were developed. These detailed estimates were made for structures in areas similar to this watershed. Other cost figures were developed from figures obtained from a preliminary design for the facility. A power pole line will have to be relocated through three of the proposed structures. This estimated cost is included in land rights costs in Table AII-73, page AII-112.

Land rights costs were estimated using current values for the land and present use of the area. Obtaining necessary easements and rights-of-way for the structures should not present a problem.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

The installation of the proposed structures measures would provide a significant degree of flood protection to approximately 12,000 acres of irrigated land and to about 400 farm houses, rural residential units, and small business establishments. In addition, irrigation facilities serving about 4,000 acres of land below the watershed would be protected from frequent damage.

After the project measures are installed, damages will be reduced to about $17,000 annually, a reduction of 95 percent. This will result in average annual damage reduction benefits of $323,600. Redevelopment and secondary benefits associated with the installation and operation of the project measures are estimated to be $99,500 annually. Average annual benefits are estimated to be $423,100. The average annual cost of structural measures including operation and maintenance is estimated to be $356,300. The benefit-cost ratio is 1.2:1.

The land treatment systems suggested for this watershed are groups of interdependent measures primarily designed to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $195,900. The average annual return is estimated to be $380,400.

ALTERNATE OR ADDITIONAL POSSIBILITIES

There are several alternate ways and routes that the discharge from the principal spillways can be carried to the Rio Grande: the channels could be taken directly to the river across the valley floor; other combinations of discharge and routes across the valley to the river; or the possibility of using channels with control structures in an unlined channel.

Additional water management and irrigation system development is a possibility and a need exists for this development. These possibilities were not considered in the report but should be investigated when a firm project plan is being developed.

TABLE AII-71. STRUCTURE DATA, HELL'S CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classification
1	144.8	70	1,114,000	R/C conduit	8	R/C chute	1	325	c
2	60.9	39	3,123,000	"	8	"	1	260	"
3	5.7	25	307,000	"	8	"	1	46	"
4	22.6	42	1,022,000	"	8	"	1	97	"
5	29.3	27	801,000	"	8	"	1	180	"

TABLE AII-72. CHANNEL DATA, HELL'S CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Channel Designation	Length of reach (100 Ft)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
Principal spillway outlet channels						
Channel 100	28	1,160	90	4.4	3.0	40,500
Channel 200	10	488	46	3.5	3.0	6,100
Channel 300	5	48	3	2.5	8.0	conc. lined
Channel 400	30	184	24	2.8	3.0	6,900
Channel 500	5	240	28	2.9	3.0	3,900

TABLE AII-73. RESERVOIR STORAGE CAPACITY, HELL'S CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
1	144.8	991	8,506	9,947	0.07
2	60.9	613	3,598	4,200	0.10
3	5.7	85	351	436	0.15
4	22.6	232	1,333	1,565	0.10
5	29.3	230	1,733	1,963	0.08

TABLE AII-74. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, HELL'S CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost				
	Construction	Installation services	Land, easements, & rights-of-way 2/	Administration of contracts	Total Installation cost
Floodwater retarding structures: Site 1	$1,303,000	$ 560,000	$ 5,500	$ 500	$1,869,000
2	1,535,000	660,000	50,000	1,000	2,246,000
3	216,000	93,000	10,000	1,000	320,000
4	650,000	280,000	4,000	1,000	935,000
5	490,000	211,000	7,000	1,000	709,000
Outlet channels: 100	59,000	20,000	16,000	2,000	97,000
200	12,000	11,000	17,500	500	41,000
300	3,000	1,000	1,500	500	6,000
400	9,000	7,000	16,000	1,000	33,000
500	8,000	5,000	10,500	500	24,000
TOTAL	$4,285,000	$1,848,000	$138,000	$9,000	$6,280,000

1/ Price base: 1969
2/ Land easement costs include costs of utility line changes and non-federal costs in channel construction.

TABLE AII-75. ANNUAL COST, HELL'S CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Structural Measures	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
FRS 1, 2, 3, 4, 5 and channel improve.	$339,400	$16,900	$356,300

1/ Amortized at 5-3/8 percent interest for 100 years
2/ Adjusted normalized prices

TABLE AII-76. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, HELL'S CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage		Damage reduction benefits
	Without project	With Project	
Flood Damage			
Agricultural			
Crop & Pasture	$139,400	$7,000	$132,400
Other Agricultural			
Irr. canals & land level	24,200	1,200	23,000
Urban	146,000	7,300	138,700
Indirect	31,000	1,500	29,500
TOTAL	$340,600	$17,000	$323,600

1/ Based on adjusted normalized prices

TABLE AII-77. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, HELL'S CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation unit	Average annual benefits 1/ Reduction	Redevelopment	Secondary	Total	Aver. annual Cost 2/	Benefit cost ratio
FRS 1, 2, 3, 4, 5, & channel improvements	$323,600	$70,000	$29,500	$423,100	$356,300	1.2:1

1/ Adjusted normalized prices
2/ From Table AII-75, page AII-113

LEGEND

Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	22
Federal Highway Number	66
Site Number	2
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Low Water Channel M.R.G.C.D.	
Good Range Management	Ic
Pinyon-Juniper Control	2a
Pinyon-Juniper Management	2b
Bottomland and Vegetation Management	5
Irrigated Land Management	6a
Critical Erosion Area	8

N

STRUCTURE LOCATION AND LAND TREATMENT MAP

HELL'S CANYON WATERSHED

UPPER RIO GRANDE BASIN NEW MEXICO

JANUARY 1971

1 0 1 2 3 4 5 MILES

SCALE 1:190,000

4-R-34711

USDA-SCS-FORT WORTH, TEX. 1975

CANYON SALES WATERSHED

(CNI 1-115)

VALENCIA COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located in the east central part of Valencia County, New Mexico. The north boundary is about 26 miles south of Albuquerque. The west boundary extends about eight miles south along the Rio Grande, and the south boundary extends eastward along the divide north of Abo Arroyo. The watershed boundary on the east is along the crest of the Manzano Mountains. For more detailed information see the Structure Location and Land Treatment Map, Canyon Sales Watershed, facing page AII-124.

State Highway 47 traverses the watershed north to south. State Highway 6 runs southeast from Los Trujillos. The communities of Tome, Adelino, La Constancia, and Los Trujillos are within the watershed, which includes an area of about 147,100 acres (229.9 square miles). The drainage pattern is generally to the west. In recent years the land in the floodplain area has been leveled and developed into highly productive irrigated cropland. In the process of leveling the land, the arroyo channels were also leveled; consequently, the arroyos drain into the main irrigation canal and have no channels to the river.

Land status in the watershed is 118,300 acres of private land; 1,200 acres of public land administered by the Bureau of Land Management; and 27,600 acres administered by the Forest Service. Of the 27,600 acres of National Forest administered land in this watershed about 3,000 acres are classed commercial and 24,600 acres non-commercial forest.

There are approximately 4,200 acres of irrigated cropland; 21,700 acres of woodland; 55,300 acres of sagebrush; 64,300 acres of grassland; and 1,600 acres of miscellaneous land.

Mean sea level elevations range from 4,800 feet at the Rio Grande to about 9,000 feet at the crest of the Manzano Mountains.

The watershed is in the Southern Desertic Basin Land Resource Area. It is included in the Mexican Highland Section of the Basin and Range Physiographic Province. Erosion rates vary up to 1.0 acre-feet/square mile/year in the watershed.

The average annual temperature is 57°F at Belen with a high of 97°F and a low of -7°F. The average annual rainfall is seven inches at Belen. Evaporation rates in this locality are high. High-intensity short duration, convective-type summer thunderstorms occur quite frequently in this vicinity.

PHOTO AII-12. TYPICAL SAND SAGE VEGETATION AND IRRIGATED LAND SUBJECT TO FLOODWATER AND SEDIMENT DAMAGE IN THE CANYON SALES WATERSHED. SCS PHOTO 12-P1021-6

WATERSHED PROBLEMS AND NEEDS

Since arroyos have no outlets to the river, they overflow the canal flooding the irrigated farmland below. Local people reported some flood damage to occur every year. About every three years approximately 1,000 acres of land are damaged to the extent that crops are lost and the land has to be releveled. When floods occur, about 1,000 acres of irrigated cropland suffer damage because canals become filled with sediment and water cannot be delivered to the fields.

Several homes in the watershed suffer damage by floodwater almost every year. Highways are damaged annually and a four-mile section of State Highway 47 has to be cleaned every time the arroyos run. About four miles of county road is damaged and must be repaired annually. The hydrologic cover condition is poor; therefore, the runoff and sediment rates are fairly high.

Flood damages, caused on the average of about every three years, are estimated at $15,000. A 100-year frequency storm would cause an estimated $200,000 of damage to roads, highways, residences, irrigation facilities, crops, and cropland by flooding about 3,100 acres of land in the floodplain or damage area.

This area is in need of land treatment and flood prevention measures to reduce the floodwater and sediment damage to residences, businesses,

highways, canals, crops, cropland, and deterioration of rangeland conditions. Subsurface drainage is needed on 420 acres; 2,600 acres need improved irrigation water management.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Any type of surface water storage is not considered feasible due to the low average annual precipitation, high evaporation rate, and the absence of suitable structure locations.

Land treatment measures that would help decrease the flood damages and increase soil cover and productivity of the land are physically possible. To achieve the flood protection desired, other structural measures will be necessary.

In the area where structures are needed the topography is quite level in the north-south direction and does not lend itself well to the installation of floodwater retarding structures. However, due to high cost of channelization, it is felt that retarding structures would be the most economical method of flood prevention.

Soil material at all potential structure sites is rated as fair to good construction material. Surface investigations of the foundations and abutments were made at each structure location. Potential sites are located in quaternary age terrace deposits underlain by Santa Fe Group geologic strata. Foundations have adequate bearing strength and adequate borrow of SC, SP, and SM. All excavation should be common and cutoffs at less than 20 feet. Unlined channels in sand, silt, and clay in the floodplain will probably scour.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The individuals contacted during the field investigation are aware of the flood hazard within this watershed. They are interested in trying to find a means to control floodwater from the arroyos and are aware of the need for agricultural water management. Much of the land is leveled and many concrete lined irrigation ditches have been installed. The conservation program is active in this area but with flood protection would proceed more rapidly.

The local people feel they would encounter few difficulties obtaining support to finance their cost of a watershed project.

It is recommended that the district conservationist and the natural resource district work with these people, and that a legal sponsoring organization be formed or existing organizations such as the county commission be approached for sponsorship of such a program.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Soil, climatic, and topographic conditions team up in the lower elevations of the watershed to make land treatment difficult and expensive, but not completely impossible. Systems include:

1. Good range management on 30,418 acres of grassland. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.
2. Phreatophyte control on 80 acres of bottomland.
3. Effective drainage systems on 420 acres of crop, pasture, and hayland.
4. Improved irrigation facilities on 2,680 acres of irrigated land.

The National Forest Project Work Inventory lists needs for vegetative management, erosion control, and timber stand improvement, all of which should be considered in work plan formulation.

Structural Measures

From a map and field reconnaissance, determination has been made that three floodwater retarding structures are needed to provide an adequate level of flood protection to the area. Potential structures would all have associated outlet channels for principal spillway discharge. The potential structures are single purpose flood prevention. Existing drains and wasteway would be used to discharge the principal spillway flow to the river. Costs and quantities are shown in Tables AII-78 through AII-81, pages AII-121 and AII-122.

The district maintains and operates the major irrigation canals and delivery system. Many of the laterals and on-farm ditches could be reorganized, lined, and adequate control structures installed. This investigation and report does not identify or evaluate specific systems that need to be developed.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

The investigation and estimates for this watershed are of reconnaissance level intensity. U. S. Geological Survey quadrangle maps and aerial photos were used with a field reconnaissance to determine potential structure locations and needs for control measures. The major item of work would be earthfill for the floodwater retarding dams. It is

proposed that the principal spillway outlet channel for Site 1 be lined with concrete from the dam to the drain. The potential structure would have a reinforced concrete emergency spillway.

Costs for installing the proposed works of improvement were made using reconnaissance level designs for the structural works and current unit prices for the type of material. A 20 percent contingency was added to the construction cost to take care of any unforeseen cost.

The proposed structures will all be located on privately owned land. The land is all rangeland and no problems are anticipated in acquiring necessary easements and rights-of-way.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

This watershed is adjacent to and could be considered a part of Hell's Canyon Watershed; therefore, the land use, crop yields, and flooding conditions are very similar to Hell's Canyon Watershed.

Agricultural and urban flood damages were adapted from Hell's Canyon Watershed and applied on a unit basis to this watershed. There are approximately 150 houses and 3,100 acres of agricultural land subject to flooding from the 100-year frequency flood.

Damaging floods are expected to begin with the two-year frequency event. Without flood protection agricultural damages are estimated to be $46,000 and urban damages $54,800 annually. Indirect damage associated with the flood hazard is expected to be about $10,000 annually. After the installation of potential project measures, these damages are expected to be reduced by about 90 percent. This reduction would yield about $99,700 in average annual benefits (Table AII-82, page AII-123). In addition to these benefits, redevelopment benefits are estimated to be $18,300, and secondary benefits $9,500. Average annual project benefits are estimated to be $127,500 (Table AII-84, page AII-124).

The average annual cost of structural measures including operation and maintenance amounts to $95,600. A benefit-cost ratio of 1.3:1 is derived by comparing total project benefits to the average annual cost of structural measures.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant onsite problems of critical flood and sediment source areas. An added and important associated effect of these systems would be the ultimate decrease in downstream damages and reduction in capacity requirements for flood control. The land treatment measures should also contribute to improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are $190,000. The average annual returns are estimated to be $357,800.

ALTERNATIVES AND OTHER POSSIBILITIES

There are potential structure sites above the locations shown in this report, but moving upstream would decrease the protection afforded. A channel from each structure to the river is a possibility; however, due to the necessity of installation of a road crossing, several ditch and channel crossings and the channels passing through high-value cropland, this possibility is not considered feasible nor practical.

TABLE AII-78. STRUCTURE DATA, CANYON SALES WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site: Number:	Drainage: area (SqMi)	Est. Height: of dam: (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface: area emer. spill. level (Ac)	Struc. Classi-fication
1	74.2	67	475,500	R/C conduit	8	R/C chute	1	260	c
2	5.5	21	396,000	"	8	"	1	69	"
3	10.4	23	396,000	"	8	"	1	130	"

TABLE AII-79. CHANNEL DATA, CANYON SALES WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Channel Designation	Length of reach (100 Ft)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
Outlet channel for principal spillway discharge:						
100	54	594	6	5.0	16	conc. lined
200	5	44	10	1.5	3	600
300	5	83	20	1.5	3	1,000

TABLE AII-80. RESERVOIR STORAGE CAPACITY, CANYON SALES WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
1	74.2	419	5,140	5,559	0.06
2	5.5	41	450	491	0.07
3	10.4	75	860	935	0.07

TABLE AII-81. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, CANYON SALES WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost				Total Installation cost
	Construction	Installation services	Land, easements, & rights-of-way 2/	Administration of contracts	
Floodwater retarding					
structure Site 1	$ 500,000	$215,000	$ 2,500	$ 500	$ 718,000
Site 2	258,000	111,000	5,500	500	375,000
Site 3	262,000	113,000	5,500	500	381,000
Principal spillway					
outlet channels 100	63,000	30,000	10,500	500	104,000
200	28,000	18,000	36,500	1,500	84,000
300	5,000	4,000	7,500	500	17,000
TOTAL	$1,116,000	$491,000	$68,000	$4,000	$1,679,000

1/ Price base 1969
2/ Includes costs for structures not cost shared under PL-566

TABLE AII-82. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, CANYON SALES WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Flood Damage			
Agricultural	$ 46,000	$ 4,600	$41,400
Urban	54,800	5,500	49,300
Indirect	10,000	1,000	9,000
TOTAL	$110,800	$11,100	$99,700

1/ Based on adjusted normalized prices

TABLE AII-83. ANNUAL COST, CANYON SALES WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Floodwater retarding structures 1, 2, 3, and channel improvements	$90,700	$4,900	$95,600

1/ Amortized at 5-3/8 percent interest for 100 years
2/ Adjusted normalized prices

TABLE AII-84. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, CANYON SALES WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average Annual Benefits 1/ Damage Reduction	Redevelopment	Secondary	Total	Aver. Annual Cost 2/	Benefit Cost Ratio
Floodwater retarding structures 1, 2, 3, and channel improve.	$99,700	$18,300	$9,500	$127,500	$95,600	1.3:1

1/ Adjusted normalized prices
2/ From Table AII-83, page AII-123

LEGEND

Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	22
Federal Highway Number	66
Site Number	2
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Outlet Channel	
Good Range Management	1c
Pinyon-Juniper Control	2a
Pinyon-Juniper Management	2b
Sagebrush Control and Management	3-1
Bottomland and Vegetation Management	5
Irrigated Land Management	6a
Miscellaneous Land	7

STRUCTURE LOCATION AND LAND TREATMENT MAP

CANYON SALES WATERSHED

UPPER RIO GRANDE BASIN NEW MEXICO

JANUARY 1971

1 0 1 2 3 4 5 MILES

SCALE 1:190,000

4-R-34712

USDA-SCS-FORT WORTH, TEX. 1975

PINO DRAW WATERSHED

(CNI 1-104)

SOCORRO COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located in the northeastern part of Socorro County about 27 miles north of Socorro. It extends from U. S. Highway 60 north along the Rio Grande for about eight miles. The north boundary extends along the divide south of Abo Arroyo. The watershed boundary to the east is along the crest of the Los Pinos Mountains. For more detailed information on the watershed see the Structure Location and Land Treatment Map, Pino Draw Watershed, facing page AII-134.

State Highway 47 traverses the watershed from north to south and U. S. Highway 60 from east to west. The communities of Las Nutrias and Veguita are within the watershed. The watershed includes an area of about 83,456 acres or 130.4 square miles, and the drainage area is generally to the west. The bottomland area along the Rio Grande is primarily irrigated cropland. As this land was developed, the arroyos were leveled and consequently have no channels to the river, but instead drain into the main irrigation canal.

All the land in the watershed is privately owned. There are approximately 3,300 acres of irrigated cropland; 9,000 acres of woodland; 2,500 acres of bottomland vegetation; and 68,650 acres of grassland.

Mean sea level elevations range from 4,800 feet where the Rio Grande passes under U. S. Highway 60 to 6,400 feet at the crest of the Los Pinos Mountains. The average annual temperature at Belen is 57°F with a high of 97°F and a low of -7°F. The average annual rainfall is seven inches at Belen. Evaporation rates are high.

The watershed is in the Southern Desertic Basins Plains and Mountains Land Resource Area. It is included in the Mexican Highland Section of the Basin and Range Physiographic Province. The watershed is within the Four-Corners Economic Development Region.

WATERSHED PROBLEMS AND NEEDS

Since the arroyos have no outlets to the river, they overflow the canal into which they empty flooding the irrigated farmland below. Some flood damages were reported every year by the local people. On the average of every three years, about 1,000 acres of land are damaged to the extent that crops are lost and the land has to be releveled.

PHOTO AII-13. FLOOD AREA NEAR GRIEGO BROTHERS RANCH HEADQUARTERS. THIS IS BELOW PROPOSED SITE 3. SCS PHOTO 12-P1001-11

Floodwaters heavily laden with sediments flow into the canals, filling them with sediments. Extensive damage to about 5,600 acres of crops located downstream from the watershed ensues due to lack of irrigation water. This includes some irrigated land outside of the watershed.

Several homes are damaged by floodwater in the communities of Las Nutrias and Veguita annually. Highways and bridges are damaged annually and a three or four mile section of State Highway 47 must be cleaned each time the arroyos flood.

The three-year frequency flood causes an estimated damage of $85,000. A flood caused by a storm equal to the 100-year frequency event would cause damages estimated to be $230,000 and inundate about 3,300 acres of agricultural land.

Approximately 13 percent of the watershed has critical erosion problems. In some areas, erosion rates are as high as three acre-feet/square mile/year.

This area is in need of land treatment and flood prevention measures to reduce the floodwater and sediment damage to residences, businesses, highways, canals, crops, and cropland. There are needs for irrigation system reorganization and improvement as well as installing on-farm ditch and water control structures.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Water-based recreation is not considered feasible due to the low average annual precipitation, high evaporation rate, and the absence of suitable structure locations.

Land treatment measures could be installed on rangeland that would encourage better cover conditions. Cropland can be treated with measures that will improve irrigation water management and enhance the productivity of the land. Due to the climate and soils the land treatment cannot meet the flood prevention need without the installation of floodwater retarding structures to control the runoff.

The topography is nearly level north to south, and fairly steep east to west. This topographic condition does not lend itself to the installation of floodwater retarding structures but, due to the high cost of channelization, it is felt that retarding structures would be the best method of flood prevention.

Borrow material at all potential structure sites is rated as fair for use in earthfill construction. Surface investigations of the foundations and abutments were made at each structure location. The sites are located in the Santa Fe Group of geologic strata, which consists of Quaternary age alluvium and terrace deposits and will present no problems of installation or maintenance of the structures. Before construction, detailed permeability investigations of abutments should be made.

There are no existing channels to outlet floodwater to the river; therefore, outlet channels for the floodwater retarding structures must be installed. The most logical alternative is to utilize the existing irrigation and drainage systems and accomplish two purposes: (1) agricultural water management, and (2) flood prevention. This can be done by installing a concrete lined outlet channel from each structure to the canal. This channel would be designed to carry the floodwater to a point where it can flow into the drain and on to the Rio Grande.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The individuals contacted during the field investigation were aware of the flood hazard within the watershed. They are interested in finding ways to control the floodwater from the arroyos. The people are also aware of the need for agricultural water management. Much of the land is leveled and some concrete lined irrigation ditches have been installed. The conservation program is very active in this area. With flood protection, the conservation program could proceed more rapidly. There is no legal organization for sponsoring a project, but the local people feel that obtaining financial support and legal sponsorship for a watershed project would present no problems.

It is recommended that the district conservationist and natural resource district work with those people and that a legal sponsoring organization be formed or existing organizations such as the county commission be approached for sponsorship of such a program.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of the watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Good range management on 36,864 acres of grassland. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities. Along Highway 47 between Las Nutrias and Highway 60 are small areas of mesquite and sand sage. At the present time, the plants are providing protection for the soil from wind erosion. As management becomes better and grass density increases, this brush can be removed.
2. Phreatophyte control on 922 acres of bottomland.
3. Effective drainage systems on 100 acres of crop, pasture, and hayland.
4. Improved irrigation facilities on 1,664 acres of irrigated land.
5. Erosion control on 9,796 acres of critically eroded land. These areas are generally on steep, poorly vegetated, unstable soils and in areas of heavy use near farmsteads and urban areas. Effective methods that may be used on land subject to critical erosion are small gully plugs, net wire fences, contour furrows, and diversions designed to stabilize the soils so grass seeding will result in protective stands of vegetation.

Structural Measures

To provide the level of flood protection that is desirable for the area being damaged, floodwater retarding structures with related outlet channels appear to afford the best solution. The potential structural works would be five floodwater retarding structures with a required capacity for sediment and floodwater of about 10,000 acre-feet. A lined channel from each structure to the Las Nutrias Lateral is proposed for Sites 1 to 4 to discharge the flow from each principal spillway. The canal would have to be enlarged to handle the additional water from flood flows. This increased flow would be released to the Las Nutrias drain and to the Rio Grande near Site 5. The principal spillway flow from Site 5 would be carried by lined channel directly to the drain and discharged into the river. The storage structures are planned as single-purpose flood prevention structures.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Investigation of the watershed was made at a reconnaissance level. A field reconnaissance was made using aerial photos and 1:24,000 U. S. Geological Survey quadrangle maps. Potential structure sites were checked on site and on the quadrangle sheets. Potential structure location on the quadrangle sheets was used to estimate structure capacity and the required earth embankment. Items of work will be earth embankment for five floodwater retarding structures, reinforced concrete chute emergency spillways at all five structures, earthwork for cleaning and enlarging the drain and irrigation lateral, and constructing a channel to the river from the drain. Concrete lined channels are proposed as principal spillway discharge channels.

The estimated cost of construction and installation services was made by applying a unit cost to the estimated embankment volume. This unit cost value was taken from curves developed from detailed data prepared for Public Law 566 projects in New Mexico. Other estimated costs are based on preliminary design for quantities from map data and applying current unit cost values to these quantities. Twenty percent of construction cost was added for contingencies.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

The proposed structural measures would provide a high degree of flood protection to approximately 3,300 acres of irrigated land, about 30 farm homes and rural residences, and to State Highway 47. Floodwater damages evaluated under present conditions amount to $171,800. This includes indirect damages. After project measures are installed, the estimated average annual damages will be reduced to $10,600. This is approximately 94 percent reduction in damages.

Redevelopment type benefits accruing to local labor that will be used in project construction, operation, and maintenance are estimated to be $29,800. In addition to these benefits, secondary benefits in the amount of $15,600 will accrue to a variety of sources.

Average annual project benefits are estimated to be $206,600, and the average annual cost of structural measures is estimated to be $149,900. The benefit cost ratio is 1.4:1.

The land treatment systems suggested for the watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $78,100. The average annual returns are estimated to be $224,600.

This watershed project will help alleviate air and water pollution and in doing so will enhance the environment.

ALTERNATIVES AND ADDITIONAL POSSIBILITIES

This report includes data about structural measures that are considered feasible at this time. There are alternate site locations but there would be a loss of control, and feasibility would be questionable. One possibility is to construct a channel from each structure to the Rio Grande; however, due to the cost of installing the necessary road crossings, ditch crossings, and because of the large amount of high value cropland involved, this possibility is not considered feasible or practical.

TABLE AII-85. STRUCTURE DATA, PINO DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classification
1	0.9	18	140,400	R/C conduit	8	R/C chute	1	20	c
2	3.4	40	140,000	"	9	"	1	40	"
3	3.0	15	124,700	"	8	"	1	46	"
4	15.6	44	216,000	"	8	"	1	105	"
5	92.0	55	1,471,500	"	8	"	1	320	"
									"

TABLE AII-86. CHANNEL DATA, PINO DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Designation	Length of reach (100 ft)	Watershed area (SqMi)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
100	28	0.9	10	1.0	1.5	5.0	Conc. lined
200	10	3.4	30	1.5	2.6	4.5	"
300	15	3.0	24	1.5	2.0	9.0	"
400	26	15.6	128	4.0	2.8	11.5	"
500	35	92.0	734	6.0	5.4	17.4	"
Main 1/	250	-	200	15.0	4.0	3.5	---

1/ Enlarged canal to carry principal spillway discharge from Sites 2, 3, and 4

TABLE AII-87. RESERVOIR STORAGE CAPACITY, PINO DRAW WATERHSED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
1	0.9	180	80	260	2.00
2	3.4	152	300	452	0.45
3	3.0	157	300	457	0.52
4	15.6	129	1,290	1,419	0.08
5	92.0	600	6,800	7,400	0.07

TABLE AII-88. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, PINO DRAW WATERHSED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures		Installation Cost				Total Installation cost
		Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	
Floodwater retarding structures	Site 1	$ 130,000	$ 56,000	$ 3,500	$ 500	$ 190,000
	Site 2	152,000	65,000	1,500	500	219,000
	Site 3	118,000	51,000	1,500	500	171,000
	Site 4	215,000	92,000	1,500	500	309,000
	Site 5	1,000,000	430,000	1,500	500	1,432,000
Channel	100	8,000	4,000	4,000 2/	1,000	17,000
	200	3,000	2,000	2,500 2/	500	8,000
	300	6,000	2,000	2,600 2/	500	11,000
	400	21,000	9,000	6,500 2/	500	37,000
	500	77,000	30,000	13,500 2/	500	121,000
Main 3/		72,000	26,000	1,500	500	100,000
TOTAL		$1,802,000	$767,000	$40,100	$6,000	$2,615,000

1/ Price base 1969 : 2/ Includes road crossing costs : 3/ Enlarged canal to carry principal spillway discharges from Sites 2, 3, and 4

TABLE AII-89. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, PINO DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage: Without Project	Estimated average annual damage: With Project	Damage reduction benefits
Flood Damage	$156,200	$ 9,020	$147,180
Indirect	15,600	1,580	14,020
TOTAL	$171,800	$10,600	$161,200

1/ Based on adjusted normalized prices

TABLE AII-90. ANNUAL COST, PINO DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

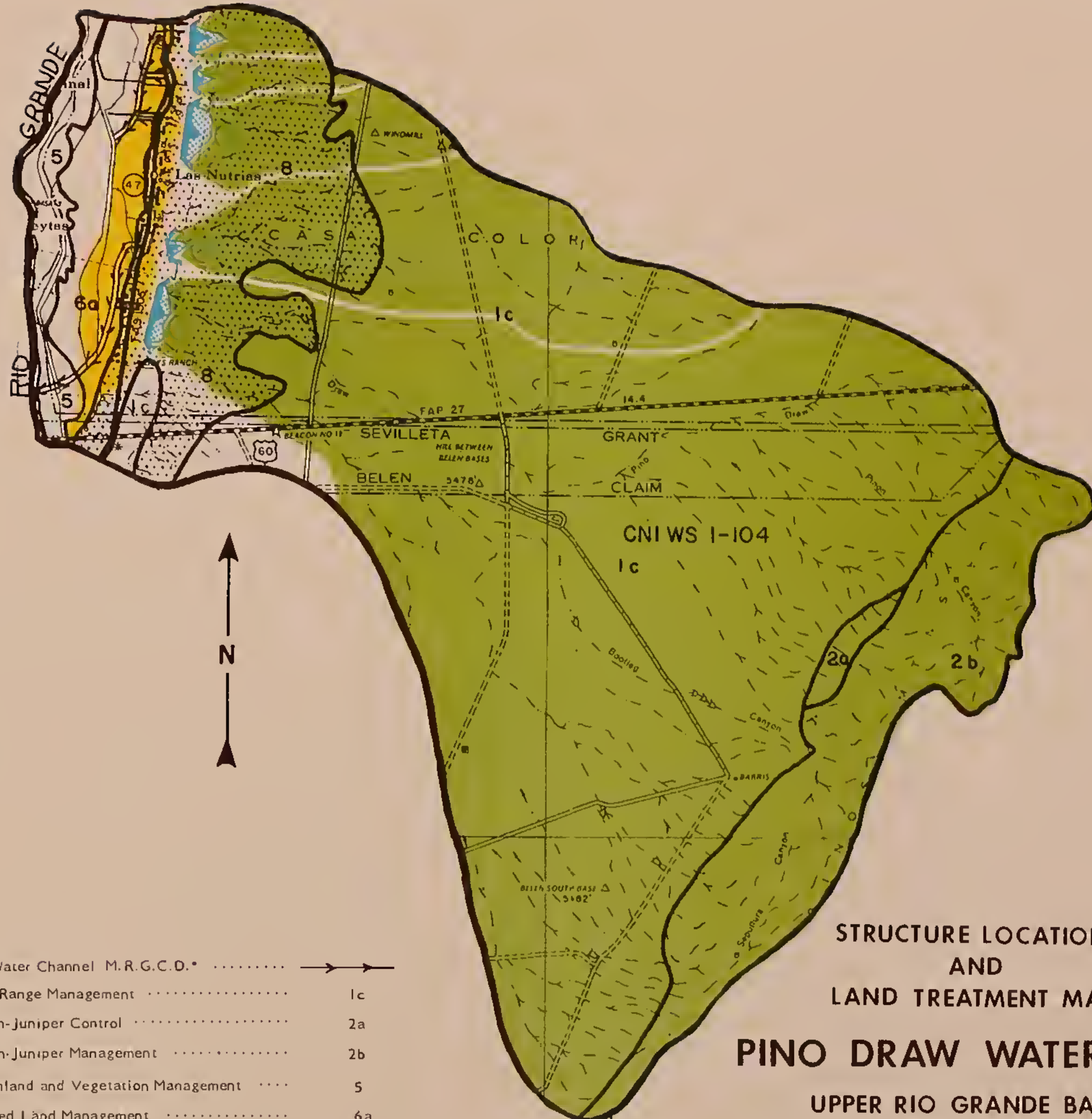
Structural Measures	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
FRS 1, 2, & 3 with channels	$ 33,300	$1,900	$ 35,200
FRS 4 & 5 with channels	108,000	6,700	114,700
TOTAL	$141,300	$8,600	$149,900

1/ Amortized at 5-3/8 percent interest for 100 years
2/ Based on adjusted normalized prices

TABLE AII-91. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, PINO DRAW WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average Annual Benefits 1/ Damage Reduction	Redevelopment	Secondary	Total	Aver. annual cost 2/	Benefit cost ratio
FRS 1, 2, & 3	$ 19,500	$ 6,900	$ 2,000	$ 28,400	$ 35,200	0.8:1
FRS 4 & 5	141,700	22,900	13,600	178,200	114,700	1.6:1
TOTAL	$161,200	$29,800	$15,600	$206,600	$149,900	1.4:1

1/ Adjusted normalized prices
2/ From Table AII-90, page AII-133



LEGEND

- Watershed Boundary
- County Boundary
- Town
- Drainage
- Divided Highway
- Paved Highway
- Gravel Road
- Unimproved Roads
- Bridge
- Railroad
- Pipeline
- Canal
- Dwelling or Farm Unit
- Business & Post Office
- School
- Church
- Cemetery
- Corral
- Windmill
- Spring
- Conservation Needs Inventory Watershed No. 1-119
- State Highway Number 22
- Federal Highway Number 66
- Site Number 2
- Potential Floodwater Retarding Structure
- Area Controlled
- Area Benefited
- Outlet Channel

- Low Water Channel M.R.G.C.D.*
- Good Range Management 1c
- Pinyon-Juniper Control 2a
- Pinyon-Juniper Management 2b
- Bottomland and Vegetation Management 5
- Irrigated Land Management 6a
- Critical Erosion Area 8

STRUCTURE LOCATION AND LAND TREATMENT MAP

PINO DRAW WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO

JANUARY 1971

2 0 2 4 MILES

SCALE 1:126,720

4-R-34713

USDA-SCS-FORT WORTH, TEX. 1975

LEMITAR-POLVADERA WATERSHED

(CNI 1-99)

SOCORRO COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The Lemitar-Polvadera Watershed is about four miles north of Socorro on the west side of the Rio Grande. The watershed begins at Nogal Arroyo and extends north for approximately 7-1/2 miles to San Lorenzo Arroyo. The arroyos included within the watershed flow from the Lemitar Mountains eastward to the Rio Grande flood plain. These arroyos originally had channels to the river but in recent years the bottomland has been leveled and developed into highly productive irrigated cropland. In the process of leveling the land the arroyo channels were also leveled and there are no channels to the river.

The watershed contains a total of 32,192 acres (50.3 square miles), of which 1,860 acres are state owned lands; 18,040 acres are federal lands administered by the Bureau of Land Management; and 12,292 acres are privately owned lands. The villages of Lemitar and Polvadera are situated within the watershed.

The Lemitar Mountains are composed primarily of the rhyolite facies of the Datil formation. Several faults within the mountains have exposed Pre-Cambrian rocks and the Madera limestone of Pennsylvanian age.

Between the mountains and Highway 85 the area is underlain by Santa Fe geologic group strata of Tertiary age. The Santa Fe geologic group consists of sand, silt, and clay, generally unconsolidated to loosely consolidated.

The two largest arroyos are entrenched in the pediment surface, which comprises the intermediate area between the mountains and the Rio Grande floodplain. Numerous other arroyos flow down the steep slopes without having cut vertical walled canyons. The average slope from the mountains to Highway 85 is approximately 260 feet per mile.

Soils of the upland area are of sandy texture, shallow, and generally rocky. Soils of the mountain slopes are either very shallow or entirely absent, with a considerable area of bare rock exposed. The pediment surface and the terraces along the principal arroyos are covered with a veneer of desert pavement. Soils of the Rio Grande floodplain are generally deep and have loamy or clayey profiles. The steep slopes are subject to sheet and gully erosion. The veneer of desert pavement aids in reducing erosion.

Average annual precipitation ranges from about 7 inches in the valley to about 11 inches in the higher elevations. The greatest amount of precipitation occurs during July, August, September, and October. The area receives some snowfall during the winter months but it is generally light and melts rapidly.

Floods are produced by high-intensity, short duration thunderstorms. The high-intensity rains, sparse vegetative cover, and steep slopes combine to produce a high degree of runoff.

Mean sea level elevations in the watershed range from 4,620 feet at the Rio Grande to 7,290 feet at the top of Polvadera peak.

The average annual temperature is about 58.4°F. The extreme temperatures on record are 108°F and 16°F below zero.

About 75 percent of the floodplain on the Rio Grande is devoted to irrigated cropland. Crops consist of cotton, alfalfa, small grains, and corn. There is some vegetable production and a few small garden tracts. There is one small cultivated area west of the highway irrigated with well water.

Irrigation water is obtained from the Rio Grande and is supplied through the canal systems of the Middle Rio Grande Conservancy District. This organization also supplies drainage protection. The district is a legal division of the state and is operated in cooperation with the Bureau of Reclamation. The San Acacia Diversion Dam diverts water from the Rio Grande into the Socorro Main Canal, which supplies water to irrigated land in the vicinity of Socorro and San Antonio. The Socorro Main Canal furnishes water to lands south from San Acacia for about 29 miles. All of the arroyos that flow to the east would have some effect on the water delivery system. A few of the irrigated tracts have irrigation wells for supplemental irrigation. Water for household use is obtained from shallow wells.

All of the land outside of the Rio Grande floodplain is classified as grazing land. The vegetation is sparse, consisting predominantly of creosote bush with some annual weeds. Carrying capacity is low. Near the mountains there is a slight increase in vegetation. Creosote bush, prickly pear, yucca, and mesquite are the brush varieties common to the watershed. At the base of the mountains clumps of bush muhly, threeawn, and dropseed occur. This area is sparsely grazed due to the lack of stock water.

Socorro County is within the Four-Corners Redevelopment Area.

WATERSHED PROBLEMS AND NEEDS

The valuable irrigated farmlands of the watershed are damaged nearly every year by floodwater from one or more of the arroyos. These damages

PHOTO AII-14. ARROYO HEADING EAST TOWARD VILLAGE OF LEMITAR.

SCS PHOTO 12-P1001-3

PHOTO AII-15. SAME ARROYO TERMINATING IN IRRIGATION CANAL. NOTE SEDIMENT ON FIELDS BELOW CANAL WHERE CANAL BANK HAS BROKEN ALLOWING SAND AND GRAVEL TO DAMAGE CROPLAND

SCS PHOTO 12-P1001-5

include loss of crops by inundation and deposition of sediment, loss of productivity due to interruption of irrigation water, loss of land due to deposition of coarse sediment, and damage to irrigation facilities.

All of the arroyos terminate against the Lemitar-Polvadera canal. The canal banks offer some protection to the lands situated east of the canal. Sediment damage to the canal causes high annual maintenance costs. Sediment-laden floodwater flows into the irrigation canals and laterals filling them with sediment and causing them to break eventually flooding the land below.

Other damage occurs to homes, stores, roads, and public utilities, particularly in the vicinity of the village of Lemitar. The Santa Fe railroad, which traverses the area from north to south, also suffers some damage.

The canals and ditches are to a large extent constructed of earth, and in some localities seepage from the canals is a problem. In the future canal and ditch lining will probably be needed. In the later summer irrigation water is in short supply.

It is estimated that the 1963 storm, which was about a 20 percent chance storm, caused damages amounting to $70,000 in the watershed. It is estimated that the 100-year frequency storm would cause $235,000 of damage to highway, residences, businesses, irrigation facilities, and inundate about 3,000 acres of agricultural land.

All the native grazing land in the watershed is subject to severe erosion. Special methods are needed to restore its productive capacity. About ten percent of the soils have a salt and alkali problem that limits crop varieties and reduces yields. The grassland and brushland also present problems. There is a lack of livestock water, so grazing during the past few years has been relatively light. Bureau of Land Management has applied limited grazing use on all land administered by them.

PHYSICAL POTENTIAL FOR MEETING NEEDS

The topography, soils, and geology of the watershed are favorable for installation of the potential structures. Adequate sites for potential structures are available.

In general, irrigated land has been provided with adequately maintained drainage facilities. Irrigation canals and laterals are well maintained. Lining of the canals would decrease seepage losses and make more water available during the time when water is low in the Rio Grande.

About 15 percent of the brushland has a soil slope combination on which brush could be removed. While this is not a popular practice, these deeper soils on moderate slopes could be cleared and reseeded to grass.

There is a possibility that the upper half of the watershed could be used for recreation purposes because of its proximity to Socorro. Presently it supports a limited population of mourning dove, quail, and deer. It has limited potential for antelope. Development of watering places and vegetative cover could increase wildlife population.

LOCAL INTEREST IN PROJECT DEVELOPMENT

An application for a Public Law 566 flood prevention project was submitted in June 1958. Authorization for planning was given in October 1959, and the first draft of the work plan was issued in February 1961. Planning was terminated September 1961 because a sponsor with legal means to assess levies and acquire rights-of-way was unavailable.

In 1968 an interest and concern for flood problems in this area were revived. Local residents and the Socorro Natural Resource District felt that the plan should be reviewed and that adequate sponsorship could be achieved, a point that will be pursued immediately. Representatives for federal land foresee no problems in complete cooperation with local people.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Good management on 3,222 acres of critically eroded land.
2. Creosote brush control on 3,135 acres of brushland.
3. Phreatophyte control on 225 acres of land.
4. Effective drainage on 370 acres of salt or alkali affected land.
5. Improved irrigation systems on 2,269 acres of irrigated land.

Structural Measures

This study has shown that four potential floodwater retarding structures and three floodwater diversions are feasible. The topography is far from ideal for dam installation but long dams can be installed and necessary storage can be obtained. As a result of topographical factors, it was decided that three floodwater diversions could be installed at less cost then retarding structures.

Channels to convey the principal spillway discharges to the river will have to be installed. It is proposed that R/C pipe be installed from Sites 2A, 3A, and 4 to the Lemitar-Polvadera irrigation lateral, and from there the combined flow will be conveyed in the canal to a point at which it can be outletted to the river. The channel to convey the principal spillway discharge into the San Lorenzo Arroyo is proposed to be in earth.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

Structure data available from the study made in 1961 was used to determine storage, volumes, and estimated heights of the structures. From the structure data developed, a unit cost for earthwork in high-hazard dams was used to determine the total construction and installation services for the structures. To determine the cost of outlet channel structures, the 1961 estimated cost was adjusted to 1969 prices. The principal items of construction will be the earthfill dams with reinforced concrete chute emergency spillways and the earthen floodwater diversions.

The entire area in and around the structure sites is pasture land in poor condition. No problems are anticipated in obtaining easements and land rights.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

The installation of the proposed structural measures will provide a high degree of protection from flood damage to about 3,000 acres of irrigated land and the irrigation systems that serve the land and protect approximately 80 rural residences and a small number of business establishments in Polvadera.

The estimated average annual floodwater and sediment damage to crops, pasture, other agricultural facilities, and roads and bridges amounts to about $58,400 based on adjusted normalized prices. Average annual urban damages within this watershed amount to about $44,800. Agricultural and urban damages, including indirect, combined, total $103,200. After project measures are installed, these damages would be reduced to $17,700, or a damage reduction of about 83 percent.

The value of local secondary benefits accruing to a project would amount to $14,500 annually. They would accrue as a result of increased net income to producers and processors of farm products and to supplies of equipment and materials required to achieve the increased production made possible by the project.

Redevelopment benefits associated with watershed project measures are estimated to be $22,300 annually. They would accrue to presently unemployed labor that would be utilized during the installation of project measures and other employment needed for operation and maintenance of structural measures.

Average annual benefits are estimated at $122,300, and average annual costs estimated to be $111,800. The benefit-cost ratio is 1.1:1.

The land treatment systems suggested for the watershed are groups of interdependent measures designed primarily to correct the dominant onsite problems of critical flood and sediment source areas. An added and

important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $90,800. The average annual returns are estimated to be $337,200.

ALTERNATE OR ADDITIONAL POSSIBILITIES

From on-site and map investigations, it appears that the flow into Site 3A can be diverted into Site 2A. This possibility needs more detailed investigation to determine physical conditions. If this is practical, the cost of increasing the capacity of Site 2A should be less than the cost for the structure on Site 3A.

Irrigation water management should also be investigated and included in a detailed and comprehensive plan for development and flood control. This would include lining of irrigation canals as a group project.

TABLE AII-92. STRUCTURE DATA, LEMITAR-POLVADERA WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway		Emergency Spillway		Max. surface area emer. spill. level (Ac)	Struc. Classification
				Type	Release rate (csm)	Type	percent chance of use		
2A	7.5	37	183,522	R/C conduit	10	R/C chute	1	85	c
3A	9.7	65	245,625	"	10	"	1	37	"
4	7.5	50	814,270	"	10	"	1	117	"
5	7.9	43	410,602	"	10	"	1	60	"

TABLE AII-93. RESERVOIR STORAGE CAPACITY, LEMITAR-POLVADERA WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
2A	7.5	208	732	940	0.28
3A	9.7	264	946	1,210	0.27
4	7.5	321	729	1,050	0.43
5	7.9	356	519	875	0.45

TABLE AII-94. CHANNEL DATA, LEMITAR-POLVADERA WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Channel Designation	Length of reach (100 Ft)	Watershed area (SqMi)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
Floodwater Diversion 301	15	9.1	3,800	290	3.2	3.9	24,000
Floodwater Diversion 401	66	2.8	1,800	200	2.2	4.0	122,200
Floodwater Diversion 501	80	3.9	2,000	200	2.5	4.0	148,000
R/C pipe (Channel for 2A)	53	-	75	3	-	10.6	-
R/C pipe (Channel for 3A)	48	-	97	3	-	13.7	-
R/C pipe (Channel for 4)	31	-	75	2.5	-	15.3	-
Channel for 5	45	-	79	1	2.4	2.4	5,800

TABLE AII-95. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, LEMITAR-POLVADERA WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost: Construction	Installation Cost: Installation services	Installation Cost: Land, easements, & rights-of-way	Installation Cost: Administration of contracts	Total Installation cost
Evaluation unit 1					
Site 2A-Canada Ancha	$ 231,000	$ 99,000	$ 2,500	$ 500	$ 333,000
Riprap irrigation ditch	3,000	1,000	-	-	4,000
Site 3A-Puertocito Canyon	267,000	114,000	2,500	500	384,000
Floodwater diversion 301	42,000	18,000	1,000	-	61,000
Outlet channel w/str.	10,000	5,000	-	-	15,000
Riprap irrigation ditch	2,000	1,000	-	-	3,000
Site 4-Chupadera Arroyo	371,000	159,000	1,500	500	532,000
Outlet channel w/str.	21,000	9,000	-	-	30,000
Riprap irrigation ditch	1,000	1,000	-	-	2,000
Floodwater diversion 401	43,000	18,000	1,500	500	63,000
Total evaluation unit 1	991,000	425,000	9,000	2,000	1,427,000
Evaluation unit 2					
Site 5 - Polvadera Arroyo	281,000	121,000	2,500	500	405,000
Outlet channel w/str.	30,000	16,000	-	-	46,000
Floodwater diversion 501	52,000	22,000	1,500	500	76,000
Total evaluation unit 2	363,000	159,000	4,000	1,000	527,000
TOTAL	$1,354,000	$584,000	$13,000	$3,000	$1,954,000

1/ Price base 1969

TABLE AII-96. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, LEMITAR-POLVADERA WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Est. average ann. damg.		Damage reduction benefits
	Without project	With project	
Floodwater Damage			
Crop and pasture	$ 22,300	$ 4,400	$17,900
Interrupted irrigation service	26,100	5,000	21,100
Urban	44,800	6,400	38,400
Subtotal	93,200	15,800	77,400
Sediment Damage	1,700	300	1,400
Indirect Damage	8,300	1,600	6,700
TOTAL	$103,200	$17,700	$85,500

1/ Based on adjusted normalized prices

TABLE AII-97. ANNUAL COST, LEMITAR-POLVADERA WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Structural Measures	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Unit 1			
FRS 2A, 3A, 4 & appurtenances	$ 77,100	$4,800	$ 81,900
Unit 2			
FRS 5 and appurtenances	28,500	1,400	29,900
TOTAL	$105,600	$6,200	$111,800

1/ Amortized at 5-3/8 percent interest for 100 years.
2/ Adjusted normalized prices

TABLE AII-98. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, LEMITAR-POLVADERA WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

	Average Annual Benefits 1/				Aver.	Benefit
Evaluation Unit	Damage Reduction	Redevelopment	Secondary	Total	Annual Cost 2/	cost ratio
Unit 1						
FRS 2A, 3A, 4, and appurtenances	$71,000	$16,400	$11,000	$ 98,400	$ 81,900	1.2:1
Unit 2						
FRS 5 and appurtenances	14,500	5,900	3,500	23,900	29,900	0.8:1
TOTAL	$85,500	$22,300	$14,500	$122,300	$111,800	1.1:1

1/ Adjusted normalized prices
2/ From Table AII-97, page AII-145

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO

LEGEND

Watershed Boundary	
Sub Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Irrigation Well	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	(22)
Federal Highway Number	(66)
Site Number	(2)
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Power Plant	
Floodwater Diversion	
Dikes or Levees (Existing)	
Outlet Channel	
R/C Pipe	
Low Water Channel M.R.G.C.D.*	
Pinyon-Juniper Management	2b
Creosote Brush Control	3a3
Creosote Brush Management	3b3
Bottomland and Vegetation Management	5
Irrigated Land Management	6a
Miscellaneous Land	7
Critical Erosion Area	8

*Area East of this channel is no longer in Watershed Treatment Area. This area is being maintained free of phreatophyte by Conservancy District.

0 1 2 MILES

SCALE 1:63,360

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

LEMITAR-POLVADERA WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

NOVEMBER 1974 4-R-34447

USDA SCS-FORT WORTH, TEX. 1974

WALNUT CREEK WATERSHED
(CNI 1-89)
SOCORRO COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is in the central part of Socorro County, New Mexico, just south of the city of Socorro. The watershed constitutes 78,490 acres (122.6 square miles). In the watershed there are 52,312 acres of public land, of which 4,700 acres are administered by the Forest Service and 40,424 acres are administered by the Bureau of Land Management; 13,523 acres are privately owned land; and 16,249 acres are state land. The Forest Service land is a portion of the Cibola National Forest and is classed entirely as non-commercial forest.

Vegetation cover and/or land use is as follows: 21,700 acres of grassland; 21,800 acres of woodland; 26,400 acres of brushland; 1,600 acres of bottomland vegetation; and 6,800 acres of irrigated cropland.

The relief pattern is to the east, draining an area on the west slope of the Magdalena Mountains. The east boundary extends about 18 miles south of Socorro along the Rio Grande. Two small communities, Luis Lopez and San Antonio, are within the watershed. Interstate 25 runs north and south through the watershed.

Mean sea level elevations range from 4,600 feet at the Rio Grande to 7,200 feet in the Magdalena Mountains. Topography in the area is steep and rough.

Climatic conditions are semi-arid with an average annual precipitation of about 9.6 inches at Socorro and about 25 inches in the mountains. Most of the precipitation occurs as rainfall from convective-type summer thunderstorms, usually of high intensity and short duration. Temperatures range from a high of 108°F to a low of -25°F, with an average of 58°F. The average frost-free period is 197 days from April 14 to October 28.

Arroyos in the watershed originally had channels with outlets into the Rio Grande channel. In recent years, however, the flat bottomland along the Rio Grande has been developed into highly productive cropland. As a result of the development, channels were leveled and the arroyos now terminate and empty into the main irrigation canal. Consequently, channels to convey flood flows to the river are non-existent.

The watershed is within the New Mexico and Arizona Plateaus and Mesas and the Arizona and New Mexico Mountains Land Resource Areas. The range condition is fair but the hydrologic cover condition over most of the area is poor.

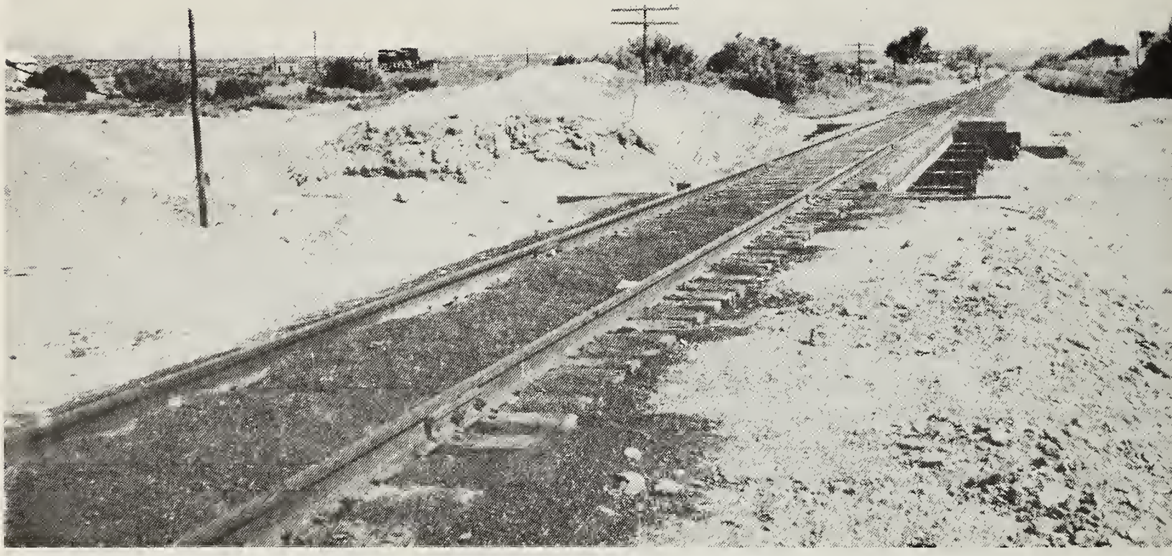


PHOTO AII-16. DAMAGE TO SANTA FE RAILROAD RIGHT-OF-WAY FROM WALNUT CREEK DRAINAGE. TRACK AND BRIDGE WERE RAISED 18 INCHES TO ALLOW MORE CLEARANCE UNDER THE TRESTLE

SCS PHOTO 12-P991-13

Erosion rates range up to 2.0 acre-feet/square mile/year within the watershed. This rate is confined to the Santa Fe Group outcrop area.

WATERSHED PROBLEMS AND NEEDS

Floodwater and sediment cause damages to roads, bridges, residences, irrigation facilities, farm equipment, and irrigated cropland. High-intensity, short-duration thunderstorms falling on rangeland with poor hydrologic cover conditions and steep topography, concentrate runoff quickly, causing large peak discharges in the arroyos. These conditions make some of the watershed area susceptible to severe erosion.

The floodwaters outlet directly into the main irrigation canal. This fills the canal with sediment causing it to break and inundate irrigated cropland. About 700 acres of cropland and crops are damaged every year from floods. Damages from interrupted irrigation occur on an additional 2,900 acres of land. Major fixed improvements such as farm and ranch homes, small businesses, roads, railroads, and irrigation canals receive considerable damage. County roads are damaged annually from flood flows. At every arroyo crossing the roads are washed out or filled with sediment.

Homes and businesses are frequently damaged in the communities of Luis Lopez and San Antonio. The agricultural area flooded by the 100-year frequency storm is estimated to be 3,660 acres. This area is used

mainly for the production of alfalfa, corn, irrigated pasture, and a small acreage of vegetables.

Agricultural damages under present conditions are estimated to total $187,000 annually. Average annual flood damages to farm and ranch homes and urban development amount to about $28,340 per year, and average annual indirect damage is estimated to be $21,540.

There is need in the watershed for land treatment and other flood prevention measures to control the floodwater and sediment discharged from the arroyos. Grazing management is needed on all areas as about one-half of the rangeland suffers from overuse. Twenty percent of the watershed is producing creosote brush, 3,000 acres of which need to be controlled. Cultivated land comprises 9 percent of the watershed, of which 220 acres need drainage and 2,700 acres need improved irrigation systems.

Land treatment measures are needed to increase the vegetative cover, decrease erosion from all sources, and increase the amount of on-site water storage. Land treatment on the irrigated cropland is needed to improve water management and lower water tables in some locations. Floodwater retarding structures are needed to supplement the land treatment program to provide the degree of protection needed.

PHOTO AII-17. A RELEVELED FIELD AFTER A BREAK IN THE CANAL. LARGER ROCKS HAVE BEEN PUSHED TO THE FENCE LINE.

SCS PHOTO 12-P991-5

PHYSICAL POTENTIAL FOR MEETING NEEDS

Due to the low average annual precipitation and high evaporation rate, subsurface water storage for any purpose is not considered feasible. However, there are many locations with potential for developing picnicking and camping on the Rio Grande and in the mountains. There are adequate locations for floodwater retarding structures to control the flooding originating in the watershed.

Sites are located in Quaternary age terrace and alluvial fan deposits that belong to the Santa Fe Group of geologic strata. Abutments will be sand and gravel and cutoff depth in channel at 25 feet or less. Borrow material is adequate although good clay-sand may be difficult to locate. All emergency spillways will be common excavation. Existing outlet channels will probably not scour more than 24 inches.

Because there are no existing channels to the river, outlet channels will have to be installed to convey the principal spillway discharges to the river.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The people contacted are aware of the floodwater problem and interested in trying to reduce it. Most of the people are conservation minded and participate in the installation and application of conservation practices.

At this time there is no legal organization for the installation, operation, and maintenance of a Public Law 566 project. Local people feel that such an organization could be formed if the flood control measures were economically feasible.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of the watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Good range management on 17,575 acres of land. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.
2. Pinyon-juniper control on 768 acres of woodland.
3. Creosote control on 3,203 acres of brushland.
4. Phreatophyte control on 1,200 acres of land.

5. Effective drainage of 220 acres of land.
6. Improved irrigation facilities on 2,741 acres of irrigated land.
7. Erosion control on 8,092 acres of critically eroded land. These areas are generally on steep, poorly vegetated, unstable soils along the major arroyos east of heavy use farmsteads and urban areas. Effective methods of erosion control include the use of small gully pluos. net wire fences, contour furrows, and diversions designed to stabilize the soils so grass seeding will produce protective stands of vegetation.

Structural Measures

Potential structural measures needed to supplement land treatment measures and to provide a desired level of protection would consist of floodwater retarding structures with related outlet channels for principal spillway flow.

Damaged areas and structure site conditions are such that 12 floodwater retarding structures would be required to provide this protection. These 12 structures would have an aggregate storage capacity for flood prevention of 9,094 acre-feet and would control about 101 square miles of the watershed. The outlet channels for units 1, 3, and 5 would be incorporated with the irrigation canal to a point at which they could be discharged into a large drain with an outlet to the Rio Grande. The other two outlet channels would cross the irrigated land and discharge directly into the drain. The storage structures would be single-purpose flood control measures. The outlet channels would in part serve as agricultural water management measures. The principal spillway discharge from Site 12 is expected to discharge into an existing diversion that diverts flood flows to the Bosque del Apache National Widlife Refuge. This flow would enhance wildlife conditions in the refuge.

Other than channel improvement and concrete canal lining to handle the principal spillway flow, no specific agricultural water management measures are identified and evaluated. Necessary improvements of the irrigation systems in the watershed would have to be a part of the planned development for the Middle Rio Grande Conservancy District. The individual systems and on-farm improvements could be improved on a watershed basis.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

The watershed investigation of flood-damage areas and potential structure sites was at a reconnaissance level. Information from U. S. Geological Survey quadrangle sheets (1:24,000 scale) and aerial photos was supplemented by a field reconnaissance of the area.

Estimates of reservoir storage capacities were developed by using the USGS quadrangle sheets. A field survey to obtain a profile of the

proposed centerline of each structure was made. These profiles were used to estimate the amount of fill needed in the potential structures.

The major items of work would be earth embankments in 12 proposed dams, one with an emergency spillway of reinforced concrete. Each potential structure would have a reinforced concrete conduit and related works as a principal spillway. The outlet works for the principal spillway discharge would consist of culverts under a state highway and under the Santa Fe Railroad. Part of the channels are designed with concrete lining and would carry flows varying from 50 to 262 cubic feet per second.

The cost estimate for construction and installation of the dams was made by applying a unit cost to the estimated embankment volume. This unit cost was obtained from a curve developed from detailed plans and costs for structures in PL-566 work plans for areas similar to this watershed. Other cost items are based on preliminary designs and quantities from map data. The unit costs are from current values and estimates made from the field reconnaissance.

Land easements and rights-of-way are not considered to be a problem; however, there are several items that would be expensive to move. Site 2 would flood an existing gravel operation and two of the sites would flood stock water wells. One site has two miles of ranch road that would have to be re-routed. Another site has an underground telephone cable near the dam axis that would have to be moved.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

The installation of the proposed structural measures would provide a high degree of protection from flood damage to about 3,500 acres of irrigated land and the associated irrigation systems, protecting about 60 residences and business properties in the community of San Antonio.

After the installation of potential structural measures, agricultural damages would be reduced to approximately $8,000 per year. This is a 95 percent reduction in damage, and it produces damage reduction benefits in the amount of $179,200 per year. Residential damages would be practically eliminated after installation of the project. Indirect damages associated with the flooded conditions amount to $21,500 per year. The installation of the project would result in a 96 percent reduction in these damages and would produce about $20,700 in average annual benefits.

The average annual cost of all structural measures including operation and maintenance is estimated to be $238,600, and total average annual benefits are estimated to be $298,000. The benefit-cost ratio is 1.2:1.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant

on-site problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

The average annual costs for the land treatment systems are estimated to be $76,500. The average annual returns are estimated to be $233,700.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Near the southwest corner of the watershed is Torreon Spring, an oasis consisting of a small lake surrounded by trees. The Bureau of Land Management has developed plans for a recreation area, part of which will be in this watershed. At the present time Torreon Spring is under private ownership and the owner is not in favor of this plan.

TABLE AII-99. STRUCTURE DATA, WALNUT CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classi-fication
1	1.8	36	68,500	R/C conduit	8	R/C chute	1	17	c
2	1.9	33	150,200	"	8	"	1	30	"
3	2.3	43	104,800	"	8	"	1	22	"
4	30.4	61	533,100	"	8	"	1	112	"
5	1.7	49	194,200	"	8	"	1	14	"
6	10.5	58	285,200	"	8	"	1	45	"
8	32.8	68	499,100	"	8	"	1	105	"
9	1.7	50	207,500	"	8	"	1	22	"
10	2.5	31	134,300	"	8	"	1	36	"
11	3.7	40	249,300	"	8	"	1	32	"
12	8.4	52	306,900	"	8	"	1	40	"
13	3.1	38	117,100	"	8	"	1	32	"

TABLE AII-100. CHANNEL DATA, WALNUT CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Channel Designation	Length of reach (100 Ft)	Watershed area (SqMi)	Needed channel capacity (Cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
Unit 1; Channel improvement for sites 1, 2, 3 & 4	87.5	5.0	50	3.0	3.0	4	conc. lined
Unit 2; Channel improvement for sites 5 & 6	27.0	30.4	243	20.0	5.0	3	14,450
Unit 3; Channel improvement for site 8	63.0	12.2	100	4.0	5.0	4	conc. lined
Unit 4; Channel improvement for sites 9, 10, 11, 12 & 13	164.0	43.8	372	7.0	9.0	12.7	conc. lined

TABLE AII-101. RESERVOIR STORAGE CAPACITY, WALNUT CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capactiy (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
1	1.8	97	170	267	0.54
2	1.9	98	170	268	0.52
3	2.3	116	220	336	0.50
4	30.4	284	2,150	2,434	0.09
5	1.7	88	170	258	0.52
6	10.5	192	760	952	0.18
8	32.8	172	2,320	2,492	0.05
9	1.7	89	200	289	0.52
10	2.5	83	230	313	0.33
11	3.7	93	370	463	0.25
12	8.4	115	560	675	0.14
13	3.1	77	270	374	0.25
TOTAL	100.8	1,504	7,590	9,094	0.15

TABLE AII-102. ANNUAL COST, WALNUT CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
No. 1, FRS 1, 2, 3 4, and channel improvement	$ 70,000	$ 3,600	$ 73,600
No. 2, FRS 5, 6, and channel improvement	37,600	1,900	39,500
No. 3, FRS 8 and channel improvement	43,500	2,200	45,700
No. 4, FRS 9, 10, 11, 12, 13, and channel improvement	75,900	3,900	79,800
TOTAL	$227,000	$11,600	$238,600

1/ Amortized at 5-3/8 percent interest for 100 years (rounded to nearest $10) 2/ Adjusted normalized prices

TABLE AII-103. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, WALNUT CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost				Total Installation cost
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	
Evaluation Unit #1					
Site 1	$ 82,000	$ 34,500	$ 1,000	$ 500	$ 118,000
Site 2	120,000	52,000	25,500	500	198,000
Site 3	113,000	48,500	1,000	500	163,000
Site 4	480,000	160,000	1,500	500	642,000
Channel Improvement	114,000	49,000	10,000	1,000	174,000
Subtotal	909,000	344,000	39,000	3,000	1,295,000
Evaluation Unit #2					
Site 5	162,000	70,000	1,500	500	234,000
Site 6	257,000	111,000	10,500	500	379,000
Channel Improvement	54,000	23,000	5,000	1,000	83,000
Subtotal	473,000	204,000	17,000	2,000	696,000
Evaluation Unit #3					
Site 8	485,000	209,000	2,000	1,000	697,000
Channel Improvement	68,000	29,000	10,000	1,000	108,000
Subtotal	553,000	238,000	12,000	2,000	805,000
Evaluation Unit #4					
Site 9	173,000	74,000	1,500	500	249,000
Site 10	117,000	50,000	500	500	168,000
Site 11	185,000	80,000	1,500	500	267,000
Site 12	255,000	110,000	500	500	366,000
Site 13	122,000	52,000	500	500	175,000
Channel Improvement	132,000	44,000	2,500	500	179,000
Subtotal	984,000	410,000	7,000	3,000	1,404,000
TOTAL	$2,919,000	$1,196,000	$75,000	$10,000	$4,200,000

1/ Price base 1969

TABLE AII-104. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, WALNUT CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Flood Damage			
Agricultural	$187,200	$8,000	$179,200
Urban	28,300	-	28,300
Indirect Damage	21,500	800	20,700
TOTAL	$237,000	$8,800	$228,200

1/ Based on adjusted normalized prices

TABLE AII-105. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, WALNUT CREEK WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

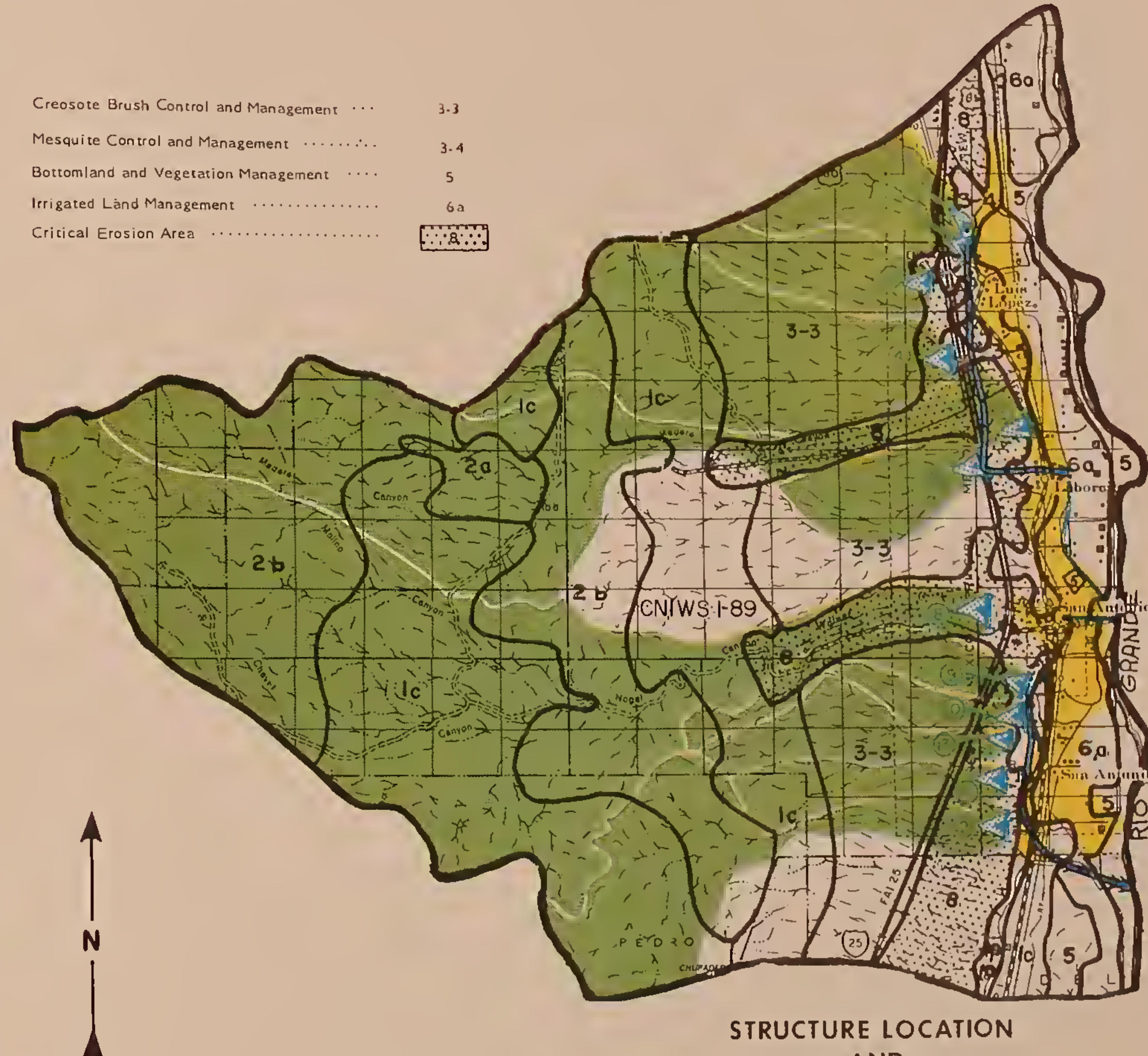
Evaluation Unit	Average Annual Benefits 1/: Damage Reduction	Redevelopment	Secondary	Total	Aver. Annual Cost 2/	Benefit cost Ratio
No. 1, FRS 1, 2, 3, 4, & channel improvement	$ 78,800	$15,000	$ 7,500	$101,300	$ 73,600	1.4:1
No. 2, FRS 5, 6, & channel improvement	43,300	7,700	4,200	55,200	39,500	1.4:1
No. 3, FRS 8 & channel improvement	53,200	9,000	5,100	67,300	45,700	1.5:1
No. 4, FRS 9, 10, 11, 12, 13, & channel improvement	52,900	16,100	5,200	74,200	79,800	1.1:1
TOTAL	$228,200	$47,800	$22,000	$298,000	$238,600	1.2:1

1/ Adjusted normalized prices
2/ From Table AII-102, page AII-156

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO

LEGEND

Watershed Boundary	
Sub Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	22
Federal Highway Number	66
Site Number	2
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Stream Channel Improvement	
Dikes or Levees (Existing)	
Outlet Channel	
Low Water Channel M.R.G.C.O.	
Good Range Management	1c
Pinyon-Juniper Control	2a
Pinyon-Juniper Management	2b
Creosote Brush Control and Management	3-3
Mesquite Control and Management	3-4
Bottomland and Vegetation Management	5
Irrigated Land Management	6a
Critical Erosion Area	8



2 0 2 4 MILES

SCALE 1:126,720

STRUCTURE LOCATION AND LAND TREATMENT MAP

WALNUT CREEK WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

NOVEMBER 1974 4-R-34444

USDA-SCS-FORT WORTH, TEX. 1974

INTERRELATED WATERSHEDS

GRANTS SUB-BASIN

San Mateo-Grants Canyon, Rio San Jose, and Pole Zuni Canyon Watersheds form a combination that contribute flood flows to a common floodplain. This floodplain includes agricultural areas and the city of Grants. These three watersheds need to be considered simultaneously in a plan to effectively utilize watershed planning resources and arrive at the most economical combination of structural measures. The Watershed Interrelationship, Grants Sub-Basin Map, facing page AII-160, shows this relationship.

DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO
WATERSHED INTERRELATIONSHIP
GRANTS SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO
OCTOBER 1970
LEGEND
Sub-Basin Boundary
Watershed Boundary
County Boundary
Area Benefited
Urban Area Benefited
Area Controlled by Existing Structure
Area Controlled by Potential Structure
Irrigation Canal
Potential Channel Improvement
Existing Reservoir
Existing Floodwater Retarding Structure
Potential Floodwater Retarding Structure
Stock Pond
le2-13 Conservation Needs Inventory Watershed Number
LOCATION MAP
McKINLEY CO.
Grants Sub-basin
VALENCIA CO.
4 0 4 8 MILES
SCALE 1:250,000
R.13 W.
R.12 W.
R.10 W.
R.9 W.
R.8 W.
R.7 W.
R.6 W.
R.5 W.
108°00'
107°30'
35°30'
35°15'
Hasta Butte
Coolidge
Continental Divide
Thoreau
A.T.& S.F.
Mitchell
Prewitt
Draw
Arroyo
Leon
Can.
Mulotto
San Miguel
Cr.
CIBOLA
NATIONAL
FOREST
San Mateo
Mt. Taylor
le2-13
le2-10
le2-16
le2-15
le2-14
le2-12
Azul
Cr.
Bluewater Lake
Clossons
Cottonwood
Bluewater
MCKINLEY CO.
VALENCIA CO.
Bluewater
Nelson Can.
Prop Can.
Pole Can.
Schneem Can.
Zuni Can.
Lobo Can.
San Mateo
Grants
CIBOLA NATIONAL FOREST
Mt Sedgewick
San Rafael
Rio
San Jose
McCarlys
Acomita
San Fidel
El Morro
NOVEMBER 1974 4-R-34441

SAN MATEO-GRANTS CANYON WATERSHED
(CNI 1e2-10)
McKINLEY AND VALENCIA COUNTIES,
NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located in McKinley and Valencia Counties in northwestern New Mexico. San Mateo Creek and Grants Canyon are tributaries to the Rio San Jose. San Mateo Creek enters the San Jose about four miles northwest of Grants, and Grants Canyon enters the river at the city of Grants.

The watershed covers an area of about 213,000 acres (332.8 square miles), of which 114,420 acres are privately owned; 11,940 acres are state land; 19,360 acres are administered by the Bureau of Land Management; 58,000 acres are National Forest; 9,000 acres are Indian land; and 280 acres are State Game Department land.

The land administered by the Forest Service is a part of the Cibola National Forest. About 11,700 acres are classed as commercial forest and 41,000 acres as non-commercial forest; 5,300 acres are classed as grasslands.

Important developments in the watershed include the Homestake Company Uranium Plant; the Atchison, Topeka and Santa Fe Railroad; U. S. Highway 66; the city of Grants; and part of the village of Milan.

The watershed is located in the New Mexico and Arizona Plateaus and Mesas and the Arizona and New Mexico Mountains Land Resource Areas. It is included in the Datil section of the Colorado Plateaus physiographic province.

Elevations range from 6,420 feet above mean sea level at Grants to 11,389 feet on Mount Taylor. Average annual rainfall is about 12 inches. Much of the watershed is grazing land with highly productive agricultural land in the broad valley northeast of Milan. High-value truck crops are grown on much of this irrigated area. The watershed is within the Four-Corners Economic Development area.

WATERSHED PROBLEMS AND NEEDS

San Mateo-Grants Canyon, San Jose, and Pole-Zuni Creeks Watershed form a combination of watersheds that contribute flood flows to a common floodplain. This floodplain includes agricultural areas and the city of Grants. These three watersheds need to be considered simultaneously

in a plan to effectively utilize watershed planning resources and arrive at the most economical combination of structural measures.

San Mateo Creek drains through a productive farmland area where no well-defined channel exists. Floodwaters cross the Atchison, Topeka and Santa Fe Railroad and U. S. Highway 66. The waters unite with the Rio San Jose and pass through the village of Milan. Floods from Zuni Canyon enter the city of Grants where Grants Canyon flows enter the river.

Floods from these drainages, individually and combined, have resulted in flooding and silt deposits in the Rio San Jose in Grants, and irrigated cropland. The resulting flood damage is to farmland, city streets, approximately 200 homes in Grants, the Atchison, Topeka and Santa Fe Railroad, and to U. S. Highway 66.

In August and September of 1967 heavy rains in the area caused intensive damage in Grants to streets, bridges, and homes. On four occasions the sewage disposal plant was completely inundated by water. If flooding continues, the disposal plant will become completely inoperative. Approximately 2,000 acres of agricultural and urban floodplain land would be inundated by the 100-year frequency flood.

The estimated average annual floodwater damage to crops, hay, and other agriculture, and roads and bridges amounts to about $23,300 based on adjusted normalized prices. Average annual urban damages within this watershed amount to about $73,500. Agriculture and urban damages combined total $96,800.

A principal need is treatment of critical erosion areas. Many of these areas have been caused by industrial exploration by mining companies and include abandoned mine sites, roads, and trails where the natural vegetation has been destroyed. Irrigated croplands need measures that will improve the application and conservation of water.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Due to low rainfall and high evaporation, surface water storage for any purpose is not feasible in the potential structures. There are adequate sites to control most of the flooding originating in the watershed.

The channel capacity of the Rio San Jose could be increased, thereby preventing the flow from entering the city of Grants by a bypass channel south of the railroad. With a channel to keep the Rio San Jose from going into Grants, the only flood hazard to the town would be Grants Canyon, which could be controlled by a retarding structure. Sediment deposition in the east edge of Grants would be confined to the channel, which could be effectively maintained by cleaning.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The watershed is in the Lava Natural Resource Conservation District. The district supervisors and the officials of the city of Grants, as well as other local citizens, are actively promoting a project for flood protection in the area.

An application has been submitted for assistance under Public Law 566 to solve flood problems in the watershed. On the recommendation of the Soil Conservation Service, the application was amended to include Grants Canyon to coordinate better the overall planning for protection in this watershed and the two adjacent ones, Pole-Zuni Canyon and the Rio San Jose. The application for assistance was submitted by the Lava Natural Resource Conservation District, the city of Grants, village of Milan, Bluewater-Toltec Irrigation District, McKinley Natural Resource Conservation District, and East Valencia Natural Resource Conservation District. The sponsors have the legal authority to sponsor, operate, and maintain a project.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of the watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Good range management on 59,172 acres of land. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.
2. Pinyon-juniper control on 37,812 acres of woodland.
3. Good management of ponderosa pine on 1,000 acres of commercial timber land.
4. Improved irrigation systems on 1,940 acres of irrigated land.
5. Erosion control on 20,048 acres of critically eroded land.

Needs as listed in the National Forest Project Work Inventory include erosion control vegetative manipulation, timber stand improvement, and fuel treatment, all of which will be considered when the project work plan is prepared.

Structural Measures

From a reconnaissance of the watershed, four potential floodwater retarding sites were selected to provide the storage necessary to control the contributing floods in the watershed. The potential structures would

control about 204 square miles or about 64 percent of the watershed. The structures would all be single-purpose control structures.

Sites 6, 7, and 8 will control contributing flow to the Rio San Jose above Milan and Grants. Site 9 on Grants Canyon will control the flows directly into the city of Grants.

A bypass channel for the Rio San Jose south of the town and railroad tracks would keep the river flow from entering the city of Grants. This channel carrying the flow from the principal spillway of the structures above and also flows from the uncontrolled areas would convey the flows past the damaged area in the city and safely discharge into the existing river channel below the city. In addition to controlling the Rio San Jose, drainage in the city would be improved due to a much smaller flow.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

The estimate of costs for the potential floodwater retarding structures was developed from data obtained from U. S. Geological Survey 7.5 minute quadrangle sheets and a surveyed centerline. A stage storage curve was developed from the quadrangle sheets. Earthfill quantities were estimated from the surveyed centerline profile. The estimated storage was based on the expected 100-year sediment yield and the expected volume of runoff from a one percent chance storm. Data for the bypass channel was taken from the quadrangle sheets. The channel is designed to carry the released flow from the control structures and from the uncontrolled area.

The estimate of cost for earthfill is based on a unit cost per cubic-yard from a 1969 curve of unit cost. The curve was developed from detailed cost estimates of similar structures in New Mexico. Other unit costs were based on similar type construction and on the judgment of engineers. Land rights costs were estimated from field observations using cost data from similar conditions in the state.

At Site 6, approximately 2.1 miles of State Highway 509 would have to be relocated. The estimated cost was based on a unit cost per square yard of surface area for completed road. The unit cost is the same as used by other agencies in New Mexico.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

The installation of structural measures proposed in this report would provide a high degree of protection from flood damage to approximately 400 acres of irrigable land and to about 400 homes and 40 commercial developments in Grants and Milan. Average annual flood damages without the project are estimated to be $96,800. After project measures are installed, these damages will be reduced to $12,000, or a damage reduction of about 88 percent.

The value of local secondary benefits accruing to the project amount to $9,600 annually. They accrue as a result of increased net income to producers and processors of farm products and to suppliers of equipment and materials required to achieve the increased production made possible by the project.

Redevelopment benefits associated with watershed project measures are estimated to be $18,000 annually. They will accrue to presently unemployed local labor, which will be utilized during the installation of project measures and other employment needed for operation and maintenance of structural measures. Average annual benefits of $112,400 compared to the average annual cost of $103,500 results in a benefit-cost ratio of 1.1:1.

The land treatment systems suggested for the watershed are groups of interdependent measures designed primarily to correct the dominant onsite problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvements, development, and preservation of watershed resources and their optimum utilization.

Total average annual cost for the land treatment systems is estimated to be $170,900. The average annual return is estimated to be $302,800.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Alternatives for controlling floodwater damages are limited, and it is felt that the potential project presented in this report is the most economical and logical method of meeting the needs. Some water storage may be possible in portions of the watershed area draining from Mount Taylor.

TABLE AII-106. STRUCTURE DATA, SAN MATEO-GRANTS CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway		Emergency Spillway		Max. surface area emer. spill. level (Ac)	Struc. Classification
				Type	Release rate (csm)	Type	percent chance of use		
6	87.2	35	133,000	R/C conduit	8	Rock	1	420	c
7	72.3	44	59,500	"	8	R/C chute	1	310	"
8	35.2	23	124,900	"	8	"	1	200	"
9	9.3	49	66,100	"	8	Rock	1	52	"

TABLE AII-107. CHANNEL DATA, SAN MATEO-GRANTS CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Channel Designation	Length of reach (100 ft)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
Grants bypass channel (rock)	130	4,000	75	6.5	6.9	247,500

TABLE AII-108. ANNUAL COST, SAN MATEO-GRANTS CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
FRS 6, 7, 8, 9, with channel	$92,100	$11,400	$103,500

1/ Amortized for 100 years at 5-3/8 percent interest for 100 years
2/ Adjusted normalized prices

TABLE AII-109. RESERVOIR STORAGE CAPACITY, SAN MATEO-GRANTS CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
6	87.6	4,230	3,950	8,180	0.48
7	72.3	3,080	3,470	6,550	0.43
8	35.2	276	1,740	8,016	0.08
9	9.3	98	480	576	0.11

TABLE AII-110. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, SAN MATEO-GRANTS CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Costs				
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	Total Installation cost
Site 6, Arroyo del Puerto	$ 77,000	$ 43,000	$130,000 2/	$1,000	$ 251,000
Site 7, San Mateo Creek	231,000	99,000	11,000 3/	1,000	342,000
Site 8, Lobo Canyon	122,000	52,000	500	500	175,000
Site 9, Grants Canyon	53,000	30,000	15,500 4/	500	99,000
Bypass Channel	517,000	98,000	221,000 5/	1,000	837,000
TOTAL	$1,000,000	$322,000	$378,000	$4,000	$1,704,000

1/ Price base 1969
2/ Includes cost of relocating 2.1 miles of Highway 509
3/ Includes cost of altering culvert on Highway 53
4/ Includes cost of relocating county road
5/ Includes cost of altering drainage structure on I-40

TABLE AII-111. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, SAN MATEO-GRANTS CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage		Damage reduction benefits
	Without project	With project	
Flood Damage			
Agricultural	$23,300	$ 4,660	$18,640
Urban	73,500	7,340	66,160
TOTAL	$96,800	$12,000	$84,800

1/ Adjusted normalized prices

TABLE AII-112. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, SAN MATEO GRANTS CANYON WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average annual benefits 1/				Aver. Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	Redevelopment	Secondary	Total		
FRS 6, 7, 8, 9 and channel improvement	$84,800	$18,000	$9,600	$112,400	$103,500	1.1:1

1/ Adjusted normalized prices
2/ From Table AII-108, page AII-166

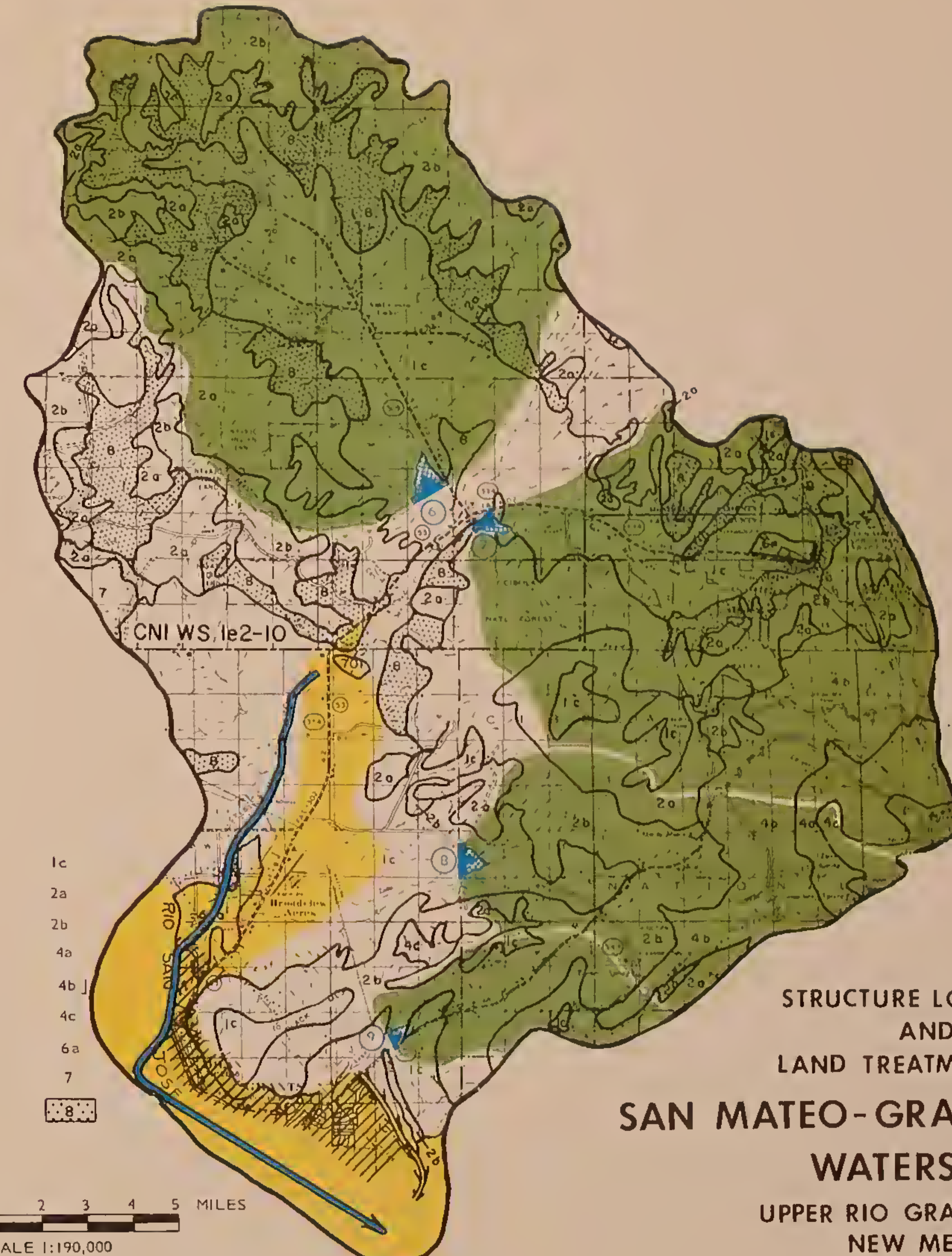
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO

LEGEND

- Watershed Boundary
- County Boundary
- Town
- Drainage
- Divided Highway
- Paved Highway
- Gravel Road
- Unimproved Roads
- Bridge
- Railroad
- Pipeline
- Canal
- Dwelling or Farm Unit
- Business & Post Office
- School
- Church
- Cemetery
- Corral
- Windmill
- Spring
- Irrigation Well
- Conservation Needs Inventory Watershed No. — 1-119
- State Highway Number — (22)
- Federal Highway Number — (66)
- Site Number — (2)
- Potential Floodwater Retarding Structure
- Area Controlled
- Area Benefited
- Urban Area Benefited
- Dam and Reservoir
- Stream Channel Improvement
- Floodwater Diversion
- Dikes or Levees (Existing)
- Outlet Channel

Good Range Management	1c
Pinyon-Juniper Control	2a
Pinyon-Juniper Management	2b
Spruce-Fir Management	4a
Ponderosa Pine Management	4b
Aspen Management	4c
Irrigated Land Management	6a
Miscellaneous Land	7
Critical Erosion Area	8

N



1 0 1 2 3 4 5 MILES

SCALE 1:190,000

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

SAN MATEO-GRANTS CANYON WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

NOVEMBER 1974 4-R-34446

USDA-SCS-FORT WORTH, TEX. 1974

POLE-ZUNI CANYONS WATERSHED

(CNI 1e2-12)

VALENCIA COUNTY, NEW MEXICO

THE WATERSHED IN BRIEF

The watershed is located west of the communities of Grants and Milan, New Mexico. It includes the drainages of Pole and Zuni Canyons and the area between the two canyons west of the Rio San Jose. The area is approximately 67,000 acres, most of which is in the Arizona and New Mexico Mountains Land Resource Area. Of this area, about 32 percent is privately owned; 55 percent is in the Cibola National Forest; 8 percent is state land; and 4 percent is administered by the Bureau of Land Management. There are about 2,900 acres of cropland previously irrigated from the Bluewater-Toltec Irrigation System and individual wells. The Grants Municipal Airport, much of the town of Milan, and a newly developed golf course west of Milan are in the lower part of the watershed.

The 37,800 acres of National Forest in this watershed are in the Gallup District of the Cibola National Forest and are classed as 26,400 acres of commercial forest; 9,500 acres non-commercial forest; and 1,900 acres of grassland.

WATERSHED PROBLEMS AND NEEDS

The entire watershed is a tributary to the Rio San Jose, which passes through Milan and Grants. Floods on the Rio San Jose cause flooding in the east end of Grants. Much of the recent development in Grants is located in the floodplain and is subject to, or receives damage from, floods. In 1967 the recently developed Milan Country Club and golf course were damaged from a flood on the arroyo by Schneeman's Ranch. The flooding extended into some homes in Milan.

Much of the 2,900 acres of cropland previously irrigated is now lying idle due to flood damage and lack of water for irrigation systems. Flood control measures are needed in order to place high-value farmland in full production, prevent damage to homes and businesses in Milan, provide protection for the Grants Municipal Airport, and reduce the contributing flow to the Rio San Jose so as to lessen the flooding in Grants. Approximately 1,500 acres of the floodplain would be inundated by the 100-year flood.

The estimated average annual floodwater damage to crops, hays, other agricultural, and public utilities amounts to $7,800 based on adjusted normalized prices. Average annual urban damages within the watershed amount to about $26,100. Agricultural and urban damages combined total $33,900.

PHOTO AII-18. POLE-ZUNI CANYONS WATERSHED AND DRAINAGE AREA FROM BLACK MESA OVERLOOKING MILAN, NEW MEXICO.

SCS PHOTO 12-P992-6

Approximately 25 percent of the grassland needs critical area management. These areas are adjacent to the irrigated land and have been heavily grazed. Some of the irrigable bottomland soils are clayey. When irrigation water that is high in soluble salt is applied to crops, the salt content tends to build up rather than leach through the profile. These clayey soils need special attention and special crops.

PHYSICAL POTENTIAL FOR MEETING NEEDS

The needs for flood protection in the watershed can be met partially by good range management supplemented by structural measures, and additional measures in the two adjoining watersheds (Rio San Jose and San Mateo-Grants). There are three sites suitable for floodwater retarding structures that have been selected. Topography and other physical conditions are favorable for construction of a floodwater diversion west of the town of Milan and Grants airport. To provide an adequate outlet channel and prevent adding to the flood damage to the town of Grants, a flood bypass channel will need to be constructed south of Grants and the railroad to carry the flow of the Rio San Jose.

Vegetative cover conditions range from poor to fair from a forage standpoint and generally poor as retarding agents for rainfall runoff.

About 11 percent of the watershed has soil and slope conditions adaptable to clearing pinyon and juniper areas of trees and brush and seeding

to grass. Managing rangeland efficiently is made difficult because of limited potential for livestock watering devices. One solution is to create artificial watersheds using plastic or asphalt catchment areas and a storage tank.

The potential structural sites are not particularly suited for recreation pools due primarily to a lack of water and high evaporation rate.

LOCAL INTEREST IN PROJECT DEVELOPMENT

Residents in the area of Grants and Milan are actively trying to promote a flood protection project. The community governing bodies are making an effort to promote a project that would provide protection for existing development and permit continued development and growth in the towns.

An application has been submitted to the Secretary of Agriculture by local organizations for assistance under Public Law 566 to solve flood problems on Pole Canyon. Applications for assistance on San Mateo and the Rio San Jose Watersheds, both adjacent watersheds, have been submitted. The local people in positions of leadership acknowledge the necessity for coordinating the efforts of the entire area of the three applications because of the common need for flood protection measures.

The local organizations responsible for submitting the applications are the Lava Natural Resource Conservation District, the town of Grants, the village of Milan, the Bluewater-Toltec Irrigation District, and Valencia and McKinley Counties. These organizations possess the legal authority necessary to meet the needs of any potential project in the watershed.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment

The land treatment systems mentioned here are important tools in the management of the watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Snowpack management on 8,800 acres of grassland.
2. Pinyon-juniper control on 7,600 acres of land.
3. Ponderosa pine management on 19,400 acres of commercial timberland.
4. Improved irrigation systems on 2,300 acres of irrigated land.
5. Erosion control on 2,300 acres of critically eroded land.

The National Forest Project Work Inventory lists need for timber stand improvement, vegetative manipulation, fuel treatment, and land treatment for erosion control as desirable projects that should be considered in the work plan preparation for this watershed.

Structural Measures

The potential structural measures within this watershed are floodwater retarding structures on Zuni Canyon, Schneeman Draw, and on Pole Canyon, and a floodwater diversion from Schneeman Draw around west of the Grants Airport to Zuni Canyon. A potential measure necessary for complete protection is a bypass channel south of Grants in the San Mateo-Grants Canyon Watershed. These potential structural measures are single-purpose flood protection measures. With the potential structures installed, 65.2 square miles, or 63 percent, of the watershed will be in the controlled area. The potential structure sites are all classed as "c" high-hazard structures.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

The basis for estimating costs of the potential structures was developed from U. S. Geological Survey 7.5 minute quadrangle sheets. A stage storage curve was developed for the floodwater retarding structures to obtain estimated capacity. A surveyed centerline was used for earthwork computations. The required storage is based on the expected 100-year sediment yield and the flood from a one percent chance storm. The flood water diversion was planned using the map data and expected flows from a one percent chance storm.

The estimated cost of the floodwater retarding structures was based on a unit cost per cubic yard of earthfill as determined from a 1969 unit cost curve. The curve was developed from data obtained in watershed work plans that are being readied for construction. The cost of the floodwater diversion was based on a unit cost per cubic yard of fill; the unit cost was obtained from similar projects throughout the state. Land rights and easements were estimated from field observations and map data using cost data from similar conditions in the state.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

The estimated average annual floodwater damage to crops, hay, other agricultural, and public utilities amounts to $7,800 based on adjusted normalized prices. Average annual urban damages in and near the village of Milan amount to about $26,100. Agricultural and urban damages combined total $33,900. After project measures are installed, these damages will be reduced to $4,500 or a damage reduction of about 87 percent. The value of local secondary benefits that will accrue to the project is estimated to be $3,000 annually. They will accrue as a result of increased net income to producers of farm products and to suppliers of equipment and materials required to achieve the increased production made possible by the project.

The average annual project benefits are estimated to be $37,200, and the average annual costs of structural measures is $25,200. This results in a benefit-cost ratio of 1.5:1.

Redevelopment benefits associated with watershed project measures are estimated to be $4,800 annually. These benefits would accrue to presently unemployed local labor that would be utilized during the installation of project measures and other employment needed for operation and maintenance of structural measures.

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant onsite problems of critical flood and sediment source areas. An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization. Total average annual cost for the land treatment systems is estimated to be $252,200. The average annual return is estimated to be $381,900.

ALTERNATIVES AND ADDITIONAL POSSIBILITIES

The potential project presented in this report is the only logical and feasible method of controlling the flood damages in the area.

There is some potential for recreation development on both Pole and Zuni Canyons.

TABLE AII-113. STRUCTURE DATA, POLE-ZUNI CANYONS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway		Emergency Spillway		Max. surface area emer. spill. level (Ac)	Struc. Classification
				Type	Release rate (csm)	Type	percent chance of use		
1	32.8	56	75,730	R/C conduit	8	Rock	1	76	c
2	5.4	27	76,300	"	8	R/C chute	1	30	"
3	26.8	38	15,600	"	8	Rock	1	80	"

TABLE AII-114. CHANNEL DATA, POLE-ZUNI CANYONS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Channel Designation	Length of reach (100 Ft)	Watershed area (SqMi)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
Floodwater Diversion (rock)	31	5.6	1,400	6	7	6.0	140,000

TABLE AII-115. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, POLE-ZUNI CANYONS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost				Total Installation cost
	Construction	Installation services	Land, easements, & rights-of-way	Administration of contracts	
Site 1, Zuni Canyon	$ 61,000	$ 34,000	$13,500 2/	$ 500	$109,000
Site 2, Schneeman Draw	86,000	37,000	2,500	500	126,000
Site 3, Pole Canyon	30,000	17,000	500	500	48,000
FWD #1	107,000	39,000	2,500	500	149,000
TOTAL	$284,000	$127,000	$19,000	$2,000	$432,000

1/ Price base 1969
2/ Includes cost of relocating a section of county highway.

TABLE AII-116. RESERVOIR STORAGE CAPACITY, POLE-ZUNI CANYONS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity	Sediment storage rate (AcFt/SqMi/Yr)
1	32.8	268	989	1,257	0.08
2	5.4	60	118	178	0.11
3	26.8	226	580	806	0.08

-Pole-Zuni Canyons Watershed (CNI 1e2-12)

TABLE AII-117. ANNUAL COST, POLE-ZUNI CANYONS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
FWR-Sites 1, 2, & 3 w/FWD #1	$23,300	$1,800	$25,100

1/ Amortized @ 5 3/8% interest for 100 yrs. (rounded to the nearest $100)

2/ Adjusted normalized prices

TABLE AII-118. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, POLE-ZUNI CANYONS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage		Damage reduction benefits
	Without project	With project	
Flood Damage			
Agricultural	$ 7,800	$1,900	$ 5,900
Urban	26,100	2,600	23,500
TOTAL	$33,900	$4,500	$29,400

1/ Based on adjusted normalized prices

TABLE AII-119. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, POLE-ZUNI CANYONS WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average Annual Benefits 1/				Aver. Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	Redevelopment	Secondary	Total		
FRS 1, 2, 3 & FWD 1	$29,400	$4,800	$3,000	$37,200	$25,100	1.5:1

1/ Based on adjusted normalized prices
2/ From Table AII-117.

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO

LEGEND

- Watershed Boundary
- County Boundary
- Town
- Drainage
- Divided Highway
- Paved Highway
- Gravel Road
- Unimproved Roads
- Bridge
- Railroad
- Pipeline
- Canal
- Dwelling or Farm Unit
- Business & Post Office
- School
- Church
- Cemetery
- Corral
- Windmill
- Spring
- Conservation Needs Inventory Watershed No. 1-119
- State Highway Number 22
- Federal Highway Number 66
- Site Number 2
- Potential Floodwater Retarding Structure
- Area Controlled
- Area Benefited
- Good Range Management 1c
- Pinyon-Juniper Control 2a
- Floodwater Diversion
- Pinyon-Juniper Management 2b
- Ponderosa Pine Management 4b
- Irrigated Land Management 6a
- Critical Erosion Area 8

N

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

POLE-ZUNI CANYONS WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

2 0 2 4 MILES
SCALE 1:126,720

NOVEMBER 1974 4-R-34443

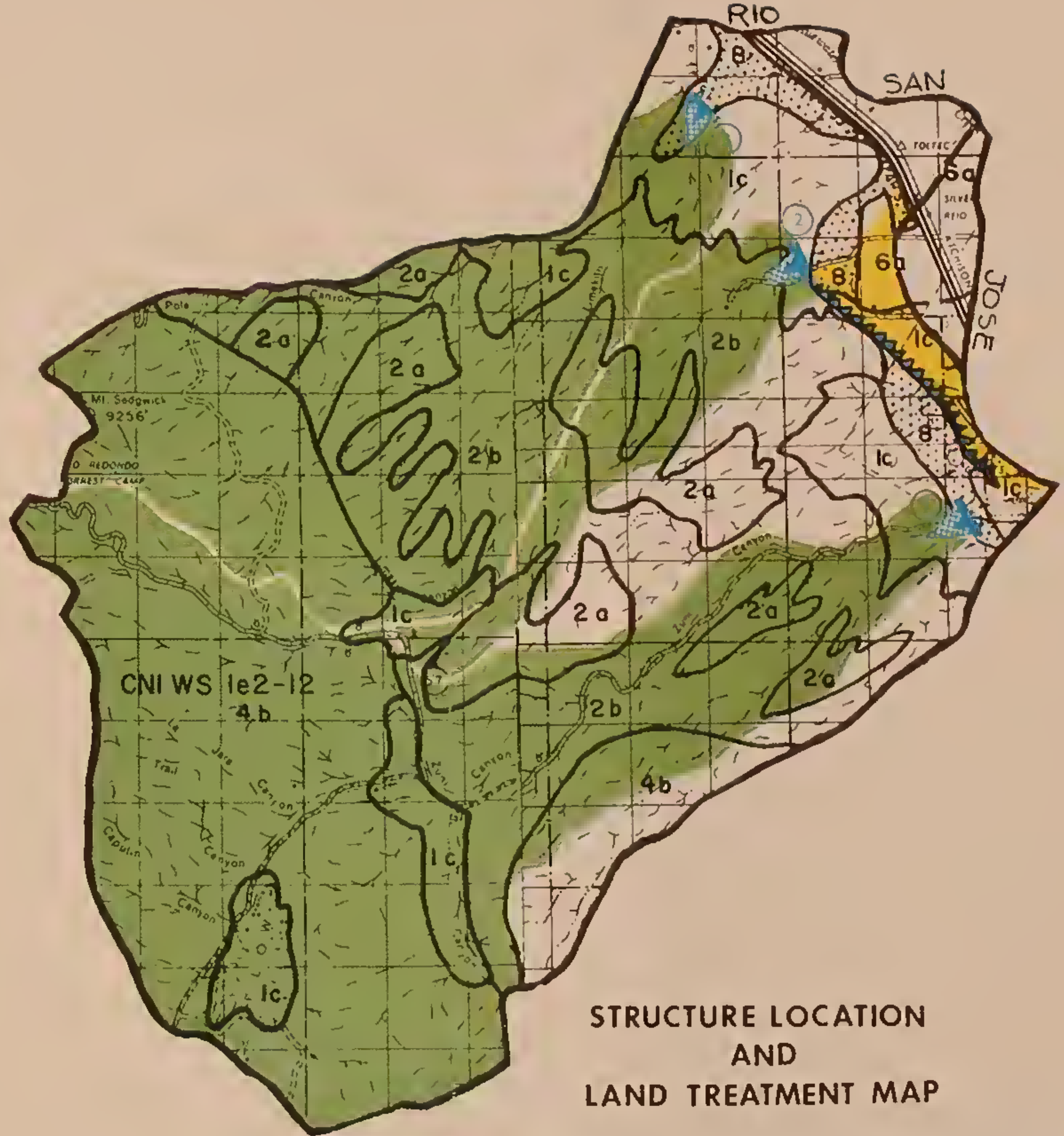
USDA-SCS-FORT WORTH, TEX. 1974

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO

LEGEND

- Watershed Boundary
- County Boundary
- Town
- Drainage
- Divided Highway
- Paved Highway
- Gravel Road
- Unimproved Roads
- Bridge
- Railroad
- Pipeline
- Canal
- Dwelling or Farm Unit
- Business & Post Office
- School
- Church
- Cemetery
- Corral
- Windmill
- Spring
- Conservation Needs Inventory Watershed No. 1-119
- State Highway Number 22
- Federal Highway Number 66
- Site Number 2
- Potential Floodwater Retarding Structure
- Area Controlled
- Area Benefited
- Good Range Management 1c
- Pinyon-Juniper Control 2a
- Floodwater Diversion
- Pinyon-Juniper Management 2b
- Ponderosa Pine Management 4b
- Irrigated Land Management 6a
- Critical Erosion Area 8

N



STRUCTURE LOCATION
AND
LAND TREATMENT MAP

POLE-ZUNI CANYONS WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

2 0 2 4 MILES
SCALE 1:126,720

NOVEMBER 1974 4-R-34443

USDA-SCS-FORT WORTH, TEX. 1974

RIO SAN JOSE WATERSHED
(CNI 1e2-13)
VALENCIA AND McKINLEY COUNTIES,
NEW MEXICO

THE WATERSHED IN BRIEF

The watershed, located generally north of Bluewater Lake and Bluewater Village, is in the northern edge of Valencia County and the south-central part of McKinley County. It includes the entire drainage area to the Rio San Jose above the Bluewater Village, approximately 224,600 acres (351 square miles). The major part of the watershed is in the New Mexico and Arizona Plateaus and Mesas Land Resource Area.

Of the total area, about 47 percent is privately owned, 37 percent is Indian land, 9 percent is managed by the Bureau of Land Management, and 7 percent is state land. There are about 1,500 acres of irrigated farm land under the Bluewater-Toltec Irrigation District that lie in the low flat area of this drainage and the San Mateo Creek Drainage. The Atchison, Topeka and Santa Fe Railroad passes through the watershed, part of which is subject to flooding and damage.

There are several industrial plants in the lower regions of the watershed that contribute to the economy of the area.

WATERSHED PROBLEMS AND NEEDS

This watershed and the San Mateo Creek drainage contribute most of the floodwaters that damage cropland and urban and industrial property downstream. Floodwaters damage truck and field crops, homes, businesses, residential areas of Grants and Milan, U. S. Highway 66, and the Atchison, Topeka and Santa Fe Railroad. Some damage is also sustained by some of the installations of the uranium refining plants.

To adequately solve the flooding problems this watershed should be planned in conjunction with the San Mateo-Grants Canyon Watershed and the Pole-Zuni Canyon Watershed. Land treatment and structural and management measures to reduce the damaging flood flows into the developed area around Grants and Milan are needed.

The estimated average annual floodwater damage to crops, hay, other agricultural and public utilities amounts to $32,700 based on adjusted normalized prices. Average annual urban damages within the watershed amount to about $109,100. Agricultural and urban damages combined make a total of $141,800. Approximately 2,000 acres of agricultural and urban land would be inundated by the 100-year frequency flood.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Within the watershed boundary much of the needed protection and rehabilitation can be accomplished by land treatment measures and proper range management. To control the floodwater that contributes to damage in the Grants, Milan, and Bluewater area, supplemental floodwater retarding structures will be required to reduce the flow to a level that can safely pass through the developed area downstream.

From a reconnaissance study of possible sites for floodwater retarding structures, it appears that physical conditions are suitable for development. Some areas of high sodium content soils occur and might pose problems in construction.

The existing channel from Bluewater to Grants could be rehabilitated and probably enlarged to discharge the controlled release from a potential structural program. The potential floodwater retarding structures are not suited to recreation due primarily to a lack of water needed to maintain a permanent pool.

An area of very sandy soil occurs north of the railroad near Thoreau. Wind erosion control could make this soil some of the more productive in the watershed. Two areas of clayey alluvial soils, one near Smith Lake and another north of Prewitt, are adaptable to practices such as contour furrowing or pitting. The permeability rates are very slow.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The local residents are actively promoting a project designed to afford protection from floods in the Bluewater, Milan, and Grants area. The community governing bodies, the local natural resource conservation districts, and county commissions are all participating in the promotion of planning a flood protection project.

An application for assistance under Public Law 566 was submitted to the Department of Agriculture in 1965. The area covered by the application contributes flood damage not only to developed areas in the watershed but also in the Pole-Zuni Canyon and San Mateo-Grants Canyon Watersheds. The local people recognize this and have applied for assistance on the three contributing watersheds. The organizations responsible for submitting the applications for assistance in flood protection have the necessary legal authorities to sponsor the proposed project.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

The land treatment systems mentioned here are important tools in the management of the watershed. Each system includes a variety of land treatment systems designed to achieve maximum landscape stability by

keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

1. Good range management on 82,900 acres of land. Grazing management is essential to all areas of rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.
2. Pinyon-juniper control on 31,100 acres of woodland.
3. Good management of ponderosa pine on 2,200 acres of commercial timber land.
4. Erosion control on 15,600 acres of critically eroded land.

Structural Measures

The potential structural measures in the watershed are two floodwater retarding structures, one near Prewitt, New Mexico, on the Rio San Jose, and the other near Andrews Ranch on Casamero Draw. The enlargement and rehabilitation of the existing channel from near Bluewater to Milan constitutes a distance of about 6.6 miles.

The potential structures are single-purpose flood protection measures and high-hazard class "c".

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

The estimated costs of the potential structural development were based on stage storage curves developed from U. S. Geological 7.5 minute quadrangle sheets supplemented with a surveyed centerline of the two floodwater retarding structures. The required storage was determined for the expected sediment yield for a 100-year period and a flood from a one percent chance storm. The estimated cost of the floodwater retarding structures was based on a unit cost per cubic yard of earthfill. The unit cost curve was plotted from planned structures with detailed cost estimates under similar conditions.

The land rights and easements costs were estimated by field observation, use of the U. S. Geological Survey quadrangle sheets, and local unit prices for land.

EFFECTS AND FEASIBILITY OF POTENTIAL DEVELOPMENT

The installation of the proposed structural measures will provide a high degree of flood protection to about 1,500 acres of irrigable cropland in the watershed. Downstream damage reduction benefits to urban property in Milan and Grants would be realized. The estimated average annual flood damages without project are $141,800. After project measures are installed, these damages will be reduced to $19,100, or a damage reduction of about 89 percent. About 92 percent of the area contributing to damages will be controlled.

PHOTO AII-19. LOOKING EAST OVER GRANTS. RIO SAN JOSE ENTERS AT RIGHT CENTER. FLOODING OCCURS IN THE AREA SHOWN ACROSS THE CENTER OF THE PHOTO. SCS PHOTO 12-P993-16

The value of local secondary benefits accruing to the project amount to $13,000 annually. They accrue as a result of increased net income to producers and processors of farm products and to suppliers of equipment and materials required to achieve the increased production made possible by the project and local effects of project operation and maintenance.

Redevelopment benefits associated with watershed project measures are estimated to be $17,900 annually. These benefits will accrue to presently unemployed local labor that will be utilized during the installation of project measures and other employment needed for operation and maintenance of structural measures.

The average annual cost of structural measures is estimated to be $88,600 and average annual benefits amount to $153,600. The benefit-cost ratio is 1.7:1.

The land treatment systems suggested for the watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effects of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. They will also contribute to the improvement, development, and preservation of watershed resources and their optimum utilization.

The total average annual costs for the land treatment systems are estimated to be $156,300. The average annual returns are estimated to be $205,300.

ALTERNATE OR ADDITIONAL POSSIBILITIES

The potential flood control measures presented in this report are considered to be the only logical and feasible methods of controlling floods from the contributing areas.

TABLE AII-120. STRUCTURE DATA, RIO SAN JOSE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Est. Height of dam (Ft)	Est. Vol. of fill (CuYd)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency Spillway Type	Emergency Spillway percent chance of use	Max. surface area emer. spill. level (Ac)	Struc. Classification
4	165.4	43	511,230	R/C conduit	8	R/C chute	1	1,120	c
5	129.5	46	49,410	"	8	Rock	1	540	"

TABLE AII-121. CHANNEL DATA, RIO SAN JOSE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Channel Designation	Length of reach (100 Ft)	Watershed area (SqMi)	Needed channel capacity (cfs)	Bottom width (Ft)	Depth (Ft)	Velocity in channel (Ft/Sec)	Estimated Volume of Excavation (CuYd)
Rio San Jose Channel	350	320	3,000	100	6.5	4.1	412,200

TABLE AII-122. DISTRIBUTION OF STRUCTURAL COST-POTENTIAL DEVELOPMENT, RIO SAN JOSE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Structural Measures	Installation Cost: Construction	Installation Cost: Installation services	Installation Cost: Land, easements, & rights-of-way	Installation Cost: Administration of contracts	Total Installation cost
Site 4, Prewitt	$ 880,000	$378,000	$1,000	$1,000	$1,260,000
Site 5, Andrews Ranch	41,000	23,000	1,500	500	66,000
Rio San Jose Channel	126,000	46,000	2,500	500	175,000
TOTAL	$1,047,000	$447,000	$5,000	$2,000	$1,501,000

1/ Price base 1969

TABLE AII-123. RESERVOIR STORAGE CAPACITY, RIO SAN JOSE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Site Number	Drainage area (SqMi)	Sediment (AcFt)	Detention (AcFt)	Total storage capacity (AcFt)	Sediment storage rate (AcFt/SqMi/Yr)
4	165.4	2,970	6,600	13,570	0.18
5	129.5	2,178	5,180	7,358	0.17

TABLE AII-124. ANNUAL COST, RIO SAN JOSE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit Structural Measures	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
FRS-Sites 4 & 5 w/channel	$81,100	$7,500	$88,600

1/ Total installation cost amortized at 5-3/8 percent interest for 100 years
2/ Adjusted normalized prices

TABLE AII-125. ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS, RIO SAN JOSE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO 1/

Item	Estimated average annual damage		Damage reduction benefits
	Without project	With project	
Flood Damage			
Agricultural	$ 32,700	$ 8,200	$ 24,500
Urban	109,100	10,900	98,200
TOTAL	$141,800	$19,100	$122,700

1/ Adjusted normalized prices

TABLE AII-126. COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES, RIO SAN JOSE WATERSHED, UPPER RIO GRANDE BASIN, NEW MEXICO

Evaluation Unit	Average Annual Benefits 1/				Aver. Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	Redevel-opment	Secon-dary	Total		
FRS 4, 5, & Rio San Jose Channel	$122,700	$17,900	$13,000	$153,600	$88,600	1.7:1

1/ Adjusted normalized prices
2/ From Table AII-124

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO

LEGEND

Watershed Boundary	
County Boundary	
Town	
Drainage	
Divided Highway	
Paved Highway	
Gravel Road	
Unimproved Roads	
Bridge	
Railroad	
Pipeline	
Canal	
Dwelling or Farm Unit	
Business & Post Office	
School	
Church	
Cemetery	
Corral	
Windmill	
Spring	
Irrigation Well	
Conservation Needs Inventory Watershed No.	1-119
State Highway Number	22
Federal Highway Number	66
Site Number	2
Potential Floodwater Retarding Structure	
Area Controlled	
Area Benefited	
Good Range Management	1c
Pinyon-Juniper Control	2a
Pinyon-Juniper Management	2b
Ponderosa Pine Management	4b
Irrigated Land Management	6a
Miscellaneous Land	7
Critical Erosion Area	8
Stream Channel Improvement	

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

RIO SAN JOSE WATERSHED

UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1971

1 0 1 2 3 4 5 MILES
SCALE 1:190,000

USDA-SCS-FORT WORTH, TEX. 1974

NOVEMBER 1974 4-R-34442